United States
Department of
Agriculture

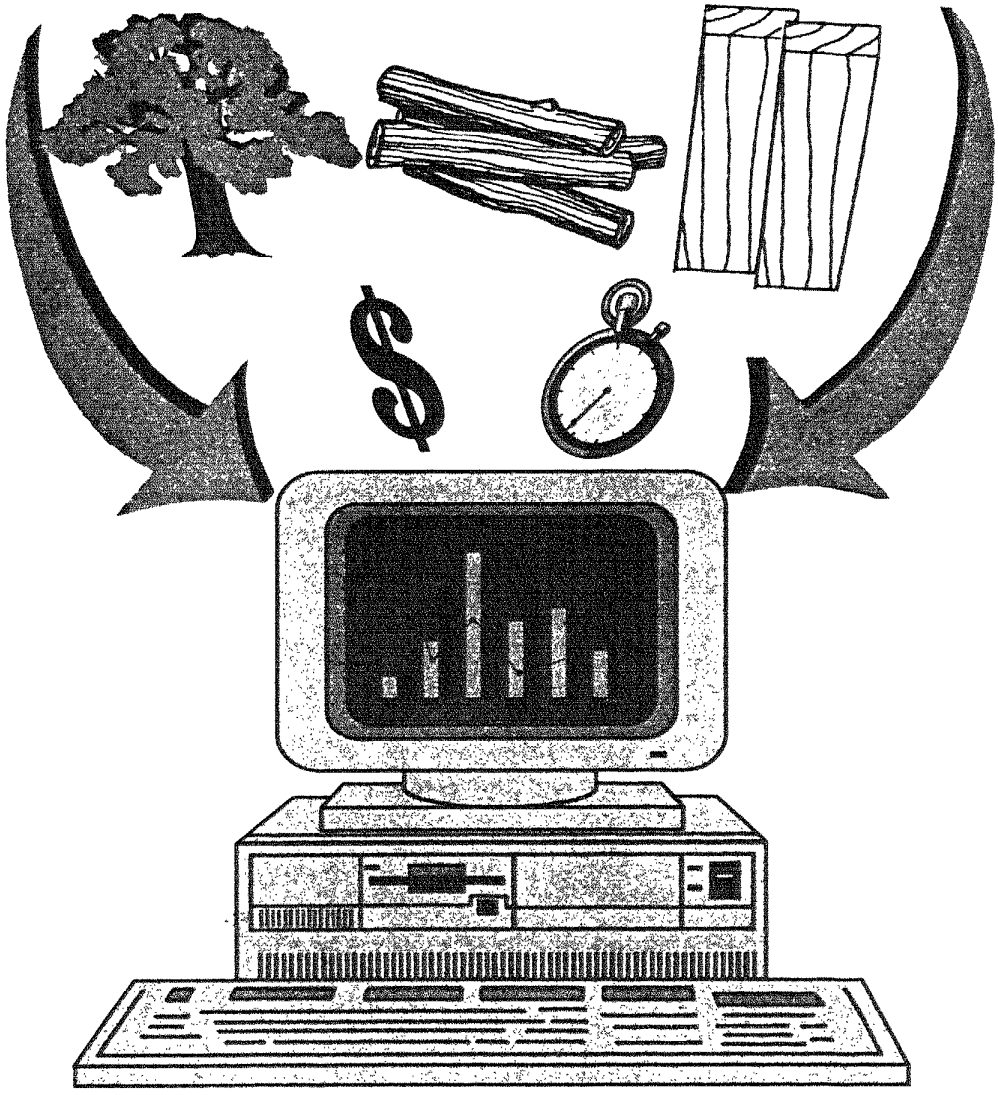
Forest Service

**Northeastern Forest
Experiment Station**

General Technical
Report NE-215

PC-SOLVE III User's Manual: A Procedural Guide for Computer-Based Sawmill Analysis

Edward L. Adams



Abstract

This is a procedural guide for using the PC-SOLVE III computer program for analyzing hardwood sawmills. The program can be used for both economic and noneconomic sawmill analysis. The economic analysis provides information on chip yields (dollars), lumber yields (dollars), product-conversion costs, and the prices that can be paid for sawlogs. The noneconomic analysis provides information on lumber overrun, lumber grade yields, lumber-recovery factor (LRF), chip yields, and sawing times. The program requires the same input data and provides the same output as the earlier PC-SOLVE II system. However, the new full-screen data forms make data entry and correction much easier. To use the program, you must have an IBM-PC compatible microcomputer with: (1) graphic capabilities, (2) a hard-disk drive, (3) a 3.5-inch (1.4 MB) disk drive, and (4) an attached printer. Although a monochrome monitor will work, a color monitor is recommended.

The Author

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Manuscript received for publication 19 May 1995

Published by:

USDA FOREST SERVICE
5 RADNOR CORP CTR SUITE 200
RADNOR PA 19087-4585

February 1996

For additional copies:

USDA Forest Service
Publications Distribution
359 Main Road
Delaware, OH 43015

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Contents

Introduction

PC-SOLVE III is a computer program for improving efficiency and solving problems in hardwood sawmills. The program provides information for both economic and noneconomic sawmill analysis. The economic analysis provides information on chip yield (in dollars), lumber yield (in dollars), and product conversion costs. From this information, the program can provide mill managers with: (1) the maximum values they can pay for their sawlogs for a preselected profit margin and (2) the break-even values they can pay for their logs with a zero profit. The simplified relationships used to provide these log values are:

1. Maximum log value = product value - conversion cost - profit.
2. Break-even log values = product value - conversion cost.

The PC-SOLVE III noneconomic analysis provides information for checking production variables such as lumber overrun, lumber grade yields, lumber-recovery factor (LRF), chip yield, and log sawing times. The program provides a variety of analytical information and is flexible enough to be used for most hardwood sawmills. Mill layout does not affect the use of the program as long as the sawn products from each log can be tracked through the mill.

PC-SOLVE III requires the same input data and provides the same output as the original SOLVE II sawmill analysis system and the later PC-SOLVE II. The original SOLVE II system (Adams and Dunmire 1977, 1978) was developed for use on a main-frame computer. The PC-SOLVE II system (Adams 1987) was developed for use on microcomputers. Also developed for use on a microcomputer, PC-SOLVE III has a much improved user interface, and it is much easier to enter, correct, or modify data. This has been accomplished with full-screen data forms.

To use PC-SOLVE III, you must have an IBM-PC compatible microcomputer with (1) graphic capabilities, (2) a hard-disk drive, (3) a 3.5-inch (1.4 MB) disk drive, and (4) an attached printer. Although a monochrome monitor will work, a color monitor is recommended.

This paper contains discussions on the program's design, data requirements, program use, program outputs, and interpretation of program outputs.

The computer program described in this publication is available on request with the understanding that the U.S. Department of Agriculture, Forest Service, cannot assure its accuracy, completeness, reliability, or suitability for any other purpose than that reported. The recipient may not assert any proprietary rights thereto nor represent it to anyone as other than a Government-produced computer program. Please write: Forestry Sciences Laboratory, 241 Mercer Springs Road, Princeton, WV 24740 to obtain a copy of PC-SOLVE III.

Mill Study for Collecting PC-SOLVE III Data

Data collection for PC-SOLVE III is a critical part of the analysis. If poor or insufficient data are input, the resulting output can be misleading or incorrect. To minimize this problem, use the following systematic procedure:

- Study the layout of the mill.
- Obtain the required general data for the sawmill.
- Select, measure, and grade the study logs.
- Test run a few nonstudy logs through the mill to work out bugs.
- Process and collect data on the study logs.

Mill Layout

When studying the layout of the mill, keep in mind that all logs must be at least partially processed through a piece of equipment that limits production. This is usually the headrig. Each sawn product must be traceable to the log from which it was sawn. In small mills, the lumber inspector can probably identify the products as they are produced. For other mills, it will be necessary to write numbers or use color codes on both the logs and the sawn products. If necessary, position individuals where they can number or code each product as it is produced. This usually requires individuals at the headsaw, resaw, edger, and trimmer. In high-speed mills, two individuals may be needed at some stations.

In addition to the individuals needed to mark the products, several more are needed. One is needed to post the log number or color code on a blackboard so that crew members can identify the log being processed. Another is needed to take log sawing times. Two individuals will probably be needed on the green chain—one to measure and grade the sawn products, another to tally the information. An extra individual also should be available to help here when needed.

Finally, one individual should be available to supervise the entire operation. This person can assure that things run smoothly and that data are collected accurately. They also should note mill situations that might affect the operation such as slabbing logs too heavily on the headrig and edging boards too heavily on the edger. These notes can be valuable in analyzing the results.

General Sawmill Data

The required general sawmill data are discussed in detail later (see SOLVEA - Data Input Module). Before deciding to do a PC-SOLVE III analysis, you should make sure that certain mill information is available. First, make sure that sufficient records are available for determining reliable mill operating costs. Records also should allow the determination of actual yearly productive time versus the total yearly operating time. If you cannot get a good handle on the operating costs and times, the PC-SOLVE III economic evaluation will be of little value.

But, even if the above information is not available, a PC-SOLVE III evaluation can still be made using only the outputs from the data summaries. These outputs give target values for log overrun, lumber yields, lumber grade yields, chip yields, and log sawing times for comparison with actual mill performance.

Study Logs

Mill evaluations should be made with only one species at a time. After the species has been chosen, you must determine how many study logs are needed in each log grade (Rast et al. 1973). The log rule used can be International 1/4-inch, Doyle, Scribner Decimal C, or Vermont. All study logs must have scaling diameters of at least 6 inches and no greater than 30 inches. The log lengths must be at least 8 feet and less than 17 feet. Odd-length logs are acceptable.

The sampling method allows you to choose a sample size relative to the error, in dollars, that is acceptable in estimating sawlog values. You must first decide how to choose the study logs. They can be chosen at random or taken mill run as they come from the log storage area. Segregate the study logs in an area where they can be stored until you are ready to process them. As the logs arrive, have them measured, scaled, graded, and numbered.

Keep a dot tally of the logs by diameter and even-length classes for each log grade as shown in Figure 1. Even-length classes as used here mean 8-, 10-, 12-, 14-, and 16-foot lengths. Odd-length logs would be rounded down to the next even-length class. In other words, a 9-foot log would be dot tallied in the 8-foot-length class, but the length would still be recorded as 9 feet on the sawlog data sheet.

Each combination of diameter and length class in Figure 1 makes up a size-class cell. In other words, the 8-inch-diameter class within the 8-foot-length class makes up one cell, and the 8-inch-diameter class within the 10-foot-length class makes up another. As the logs are dot tallied in these cells, periodically count the number of cells containing at least one dot. Divide this number into the total number of study logs in the grade to determine the average number of logs per size class in the sample. Then use Table 1 to estimate the maximum error that can be expected 95 times out of 100 if this sample size is used.

For example, if for a given grade and species of sawlog you have a total of 60 logs distributed over 10 cells, you have an average of six logs per size class. In Table 1, you will find an error of $10 per MBF for this sample size. This means that if you ran an analysis with this 60-log sample, the average log values in both the maximum sawlog value table and the zero profit value table would not be off more that $10 per MBF (95 times out of 100). This procedure should be continued until the sample size is sufficient to indicate a satisfactory error in Table 1. An error of $10 per MBF should be satisfactory for most applications.

Table 1.—Error, in dollars, for given average number of logs per size class

Average number logs	Error (Dollars per MBF)
2	26
3	18
4	14
5	12
6	10
7	9
8	8
9	7
10	7

When making the final selection of the logs to be used in the study, a few large logs should not be included in a sample of small logs. If there are only a few logs in a length class, they also should be excluded. For example, in Figure 1 the log in the 14-inch-diameter class and the two logs in the 15-inch-diameter class should be excluded. The three logs in the 16-foot-length class also might be excluded. A few logs outside the prevailing size classes can have an adverse effect on the results.

Grouping the logs by size class will not always be easy. In the example shown, some analysts might feel that the two logs in the 10-inch-length class should be excluded and the three logs in the 16-foot-length class should be included. The analyst must make these decisions based on knowledge of the mill's typical distribution of log sizes. However, if in doubt about a given size class, include it. After the data are processed by PC-SOLVE-III, the questionable log data can be checked in the computer outputs. These outputs include graphs showing plots of both the data points and the resulting regression lines for sawing times, board-foot yields, and dollar yields of the study logs. If these graphs show that the questionable log data do not fit the general trend of the other data, that data can be removed and a new computer run made.

Test Run

Before you saw the study logs, make a test run. Make sure that the mill is in good repair and that the individuals operating the various pieces of equipment are the regular operators. When your crew and the mill are ready, number a few nonstudy logs and have them processed through the mill. This will give you a chance to see that your crew is positioned properly and that each knows their job. Some adjustments may be necessary during the test run.

Processing

After you have conducted the test run, you are ready to process the study logs. While collecting the data, each recorder should note any unusual occurrence that might affect the results. This would include things such as: boards lost to the chipper, unnumbered boards, reasons for unusual delays, and sawing problems. This can help explain irregularities that may be found later.

As mentioned earlier, it is important to have a supervisor watch the entire operation. This individual should look for milling practices that might affect overrun, lumber-recovery factor, lumber grade yield, production rate, down time, and so on. This type of information can prove valuable when the study results are analyzed.

Species: WHITE OAK Grade: 3

Diameter (inches)	Log length (feet)				
	8	10	12	14	16
8	8	9	8	5	1
9	5	7	12	6	
10	3		4	3	2
11		2			
12					
13					
14	1				
15			1	1	

Figure 1.—Dot tally of study logs by diameter and even-length class.

Using the PC-SOLVE III Computer Program

PC-SOLVE III consists of seven computer modules, six data files, and three batch files. An installation program automatically installs these files on your hard drive. To install the PC-SOLVE III program, put the program diskette in your floppy disk drive and switch to that drive (type "a:" or "b:"). Type "install" at the DOS prompt (e.g. a:\install). The files will be automatically installed in a new directory named "SOLVE."

The following instructions explain how to use the four parts of the system. Part one (SOLVEA) provides instructions for entering the study data. Part two (SOLVEB) provides instructions for obtaining the first set of outputs (Output 1) for a noneconomic analysis of a mill. Part three (SOLVEC) provides instructions for obtaining the second set of outputs (Output 2) for both a noneconomic and an economic analysis of a mill. Part four (CONV) provides instructions for converting mill data files used with the PC-SOLVE II system so that they can be used with the PC-SOLVE III system.

SOLVEA - Data Input Module

This section discusses the data required to run PC-SOLVE III and how to use SOLVEA to enter and edit sawmill input data. The system uses full-screen data entry forms to make the task as easy as possible. Examples of these forms are shown in the following discussion along with sample input data to aid in explaining their use. The discussion is divided into: startup, basic sawmill data, basic species data, expected lumber grade yields, chip yields, and sawlog and lumber yield data.

In this discussion, references will be made to choosing data fields or command boxes. This can be done in either of two ways. If you do not have a mouse or you would rather use the

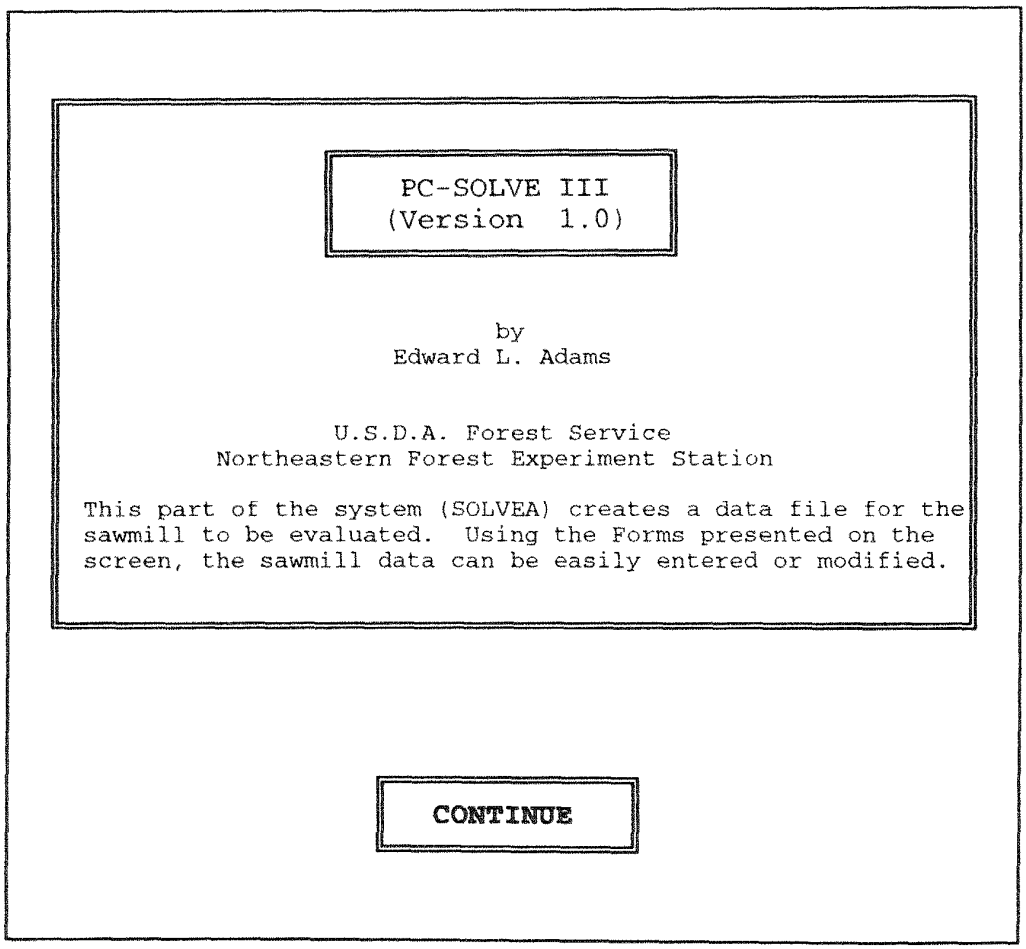

Figure 2.—Title form for the SOLVEA part of PC-SOLVE III.

keyboard, choices can be made by moving the screen cursor to the desired location with the arrow keys on the keyboard and pressing "ENTER." If you would rather use a mouse, move the mouse pointer to the desired location and press the left mouse button.

Startup

To start, move from the ROOT directory of the hard drive to the SOLVE directory by typing "CD SOLVE" and pressing "ENTER." Then, type "SOLVEA" and press "ENTER." The first screen that appears is the title form (Fig. 2), which gives basic program information including the version number of the PC-SOLVE III system and a brief program overview. When you are ready to continue, choose "CONTINUE."

Figure 3 shows the next form. It provides an explanation of the terms shown in parentheses on the forms. For example, when the term "(Y/N)" appears and the cursor is moved to the data field, the "SPACE BAR" or mouse button can be used to toggle between yes (Y) and no (N). After the selection is made, press "ENTER." When the term "(F1)" appears, press "F1" to see a note about the data to be entered. When the term "(CHOICE)" appears and the cursor or mouse pointer is moved to that field, choices can be shown by pressing the "SPACE BAR" or left mouse button. Selections are made by using the up/down arrow keys or mouse then pressing "ENTER."

Near the bottom of this form the user is asked if this is a new data file. Notice that the term "(Y/N)" appears after the question. If you are starting a new mill data file, you would toggle the

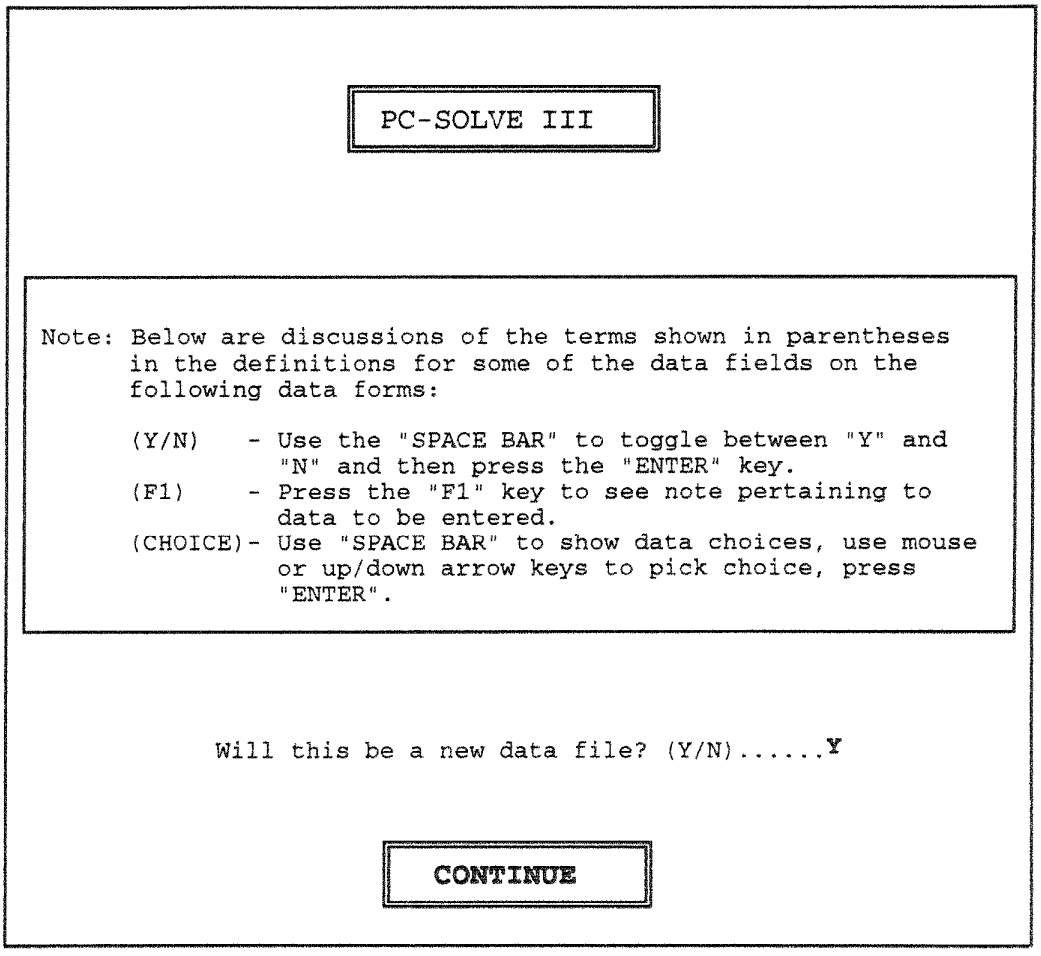

Figure 3.—Form for designating whether the user will be creating a new data file or working with an existing file when running the SOLVEA.

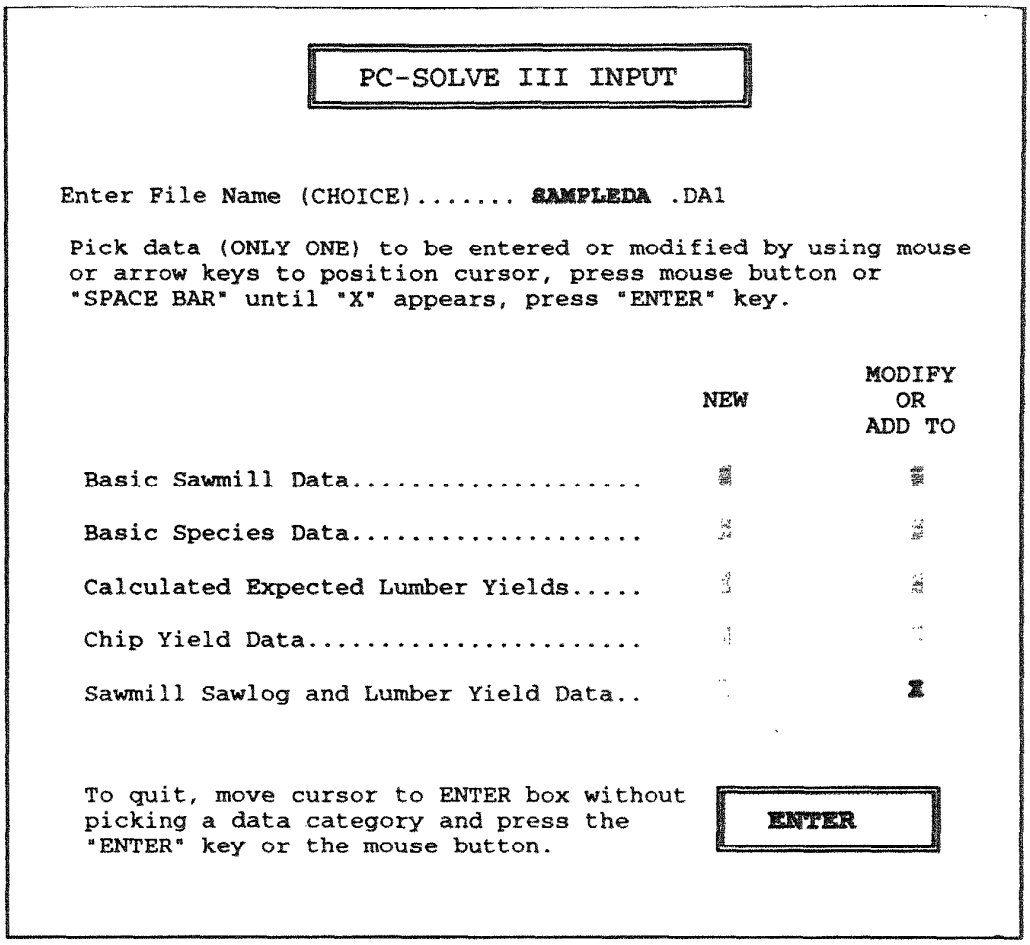

Figure 4.—Form for choosing the data input option desired by the user.

data field to "Y" and press "ENTER." If you are going to edit or add to an existing data file, you would toggle the data field to "N" and press "ENTER." To proceed, choose "CONTINUE."

Figure 4 shows the next data form (PC-SOLVE III INPUT). Notice that near the top of the form where the user is asked to enter the file name, the term "(CHOICE)" appears. This appears only if the user indicated that this was not to be a new data file. In other words, the user is planning to edit or add to an existing data file. When the user chooses the data field, a list of the existing data files is provided as shown in Figure 5. The desired file is then chosen from this list. However, if "new data file" was indicated on the previous form, the user would type the name of the new data file into the data field. The name **must** contain eight characters.

Once the file name has been entered, the user must select a data input option. As shown in Figure 5, options are available for entering new data to the file and for modifying or adding to an existing data file. These options are available for basic sawmill data, basic species data, calculated expected lumber yields, chip yield data, and sawmill sawlog and lumber yield data. If arrow keys are used to choose your data input option, move the screen cursor to the data field representing the input option and data type you want. Then, press "ENTER." If the mouse is being used, move the mouse pointer to the data field and double click the left mouse button. Make sure that you choose only one data option—only one of the 10 boxes should contain an X. Once an "X" appears in the data field, choose "ENTER" to continue.

The program always returns to this form once you have finished entering the information for the selected data type. You can then choose another data type or end the SOLVEA session by not choosing a data type and moving the cursor to the "ENTER" box as instructed at the bottom of the form.

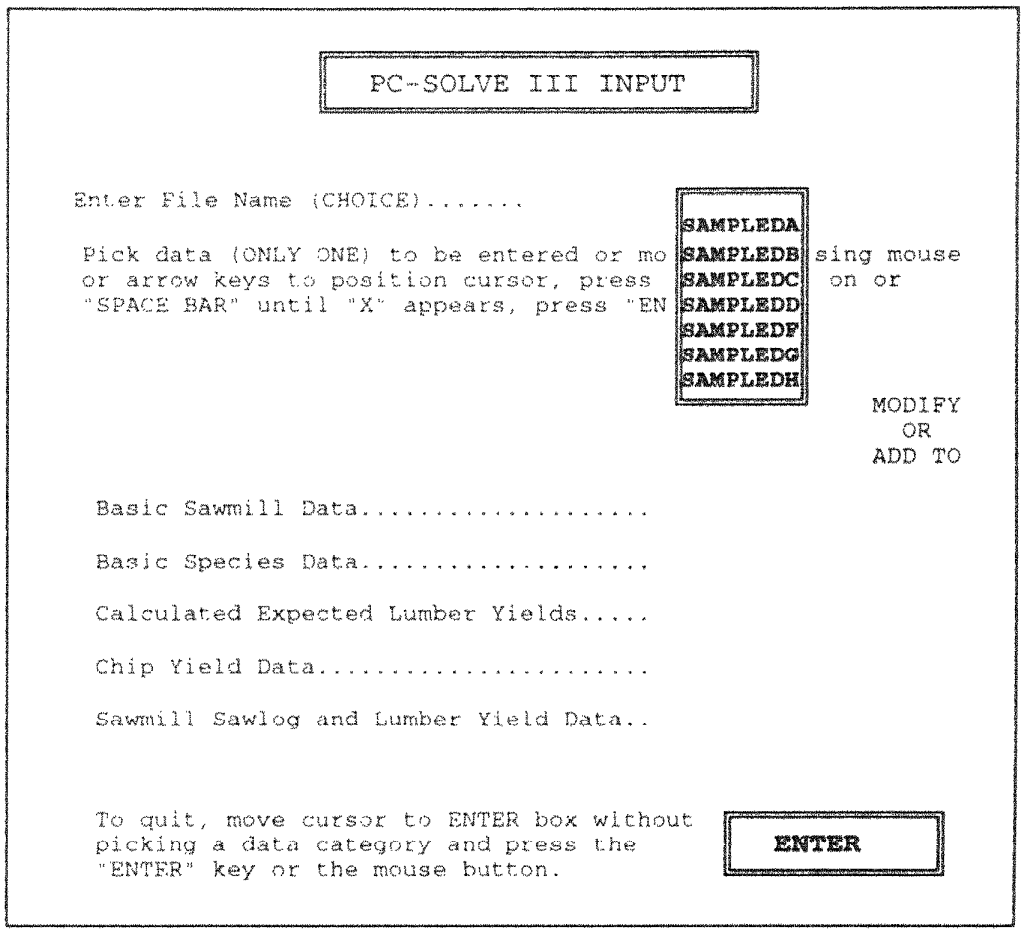

Figure 5.—Same form as that shown in Figure 4 with an example of the data file list provided by the computer program.

Basic Sawmill Data

Figure 6 shows the form that will appear if you select one of the two data fields for "Basic Sawmill Data" on the PC-SOLVE III INPUT form. If you were creating a new data file, the data fields would be blank. This figure represents a situation where the data file already exists and the user chose the "modify or add to" data field. A list and discussion of the data-entry fields follows:

- Sawmill name or identification code.
- Mill type. Notice that the form has the term "(F1)" following data definition. Pressing "F1" produces a note showing the appropriate mill type codes:
  - 1 - Band
  - 2 - Circular
  - 3 - Scragg
  - 4 - Circular w/resaw
  - 5 - Band w/resaw

- Date - the date of mill evaluation.
- Operating cost/minute - to determine this cost for the sawmill, you must divide the total yearly cost by the total number of minutes the mill was in operation during the year.

Both the cost and operating time must be determined as accurately as possible. The total yearly cost should include all operating costs incurred by the sawmill from the log yard through lumber shipping. Make sure you include the cost for all salaries, wages, FICA taxes,

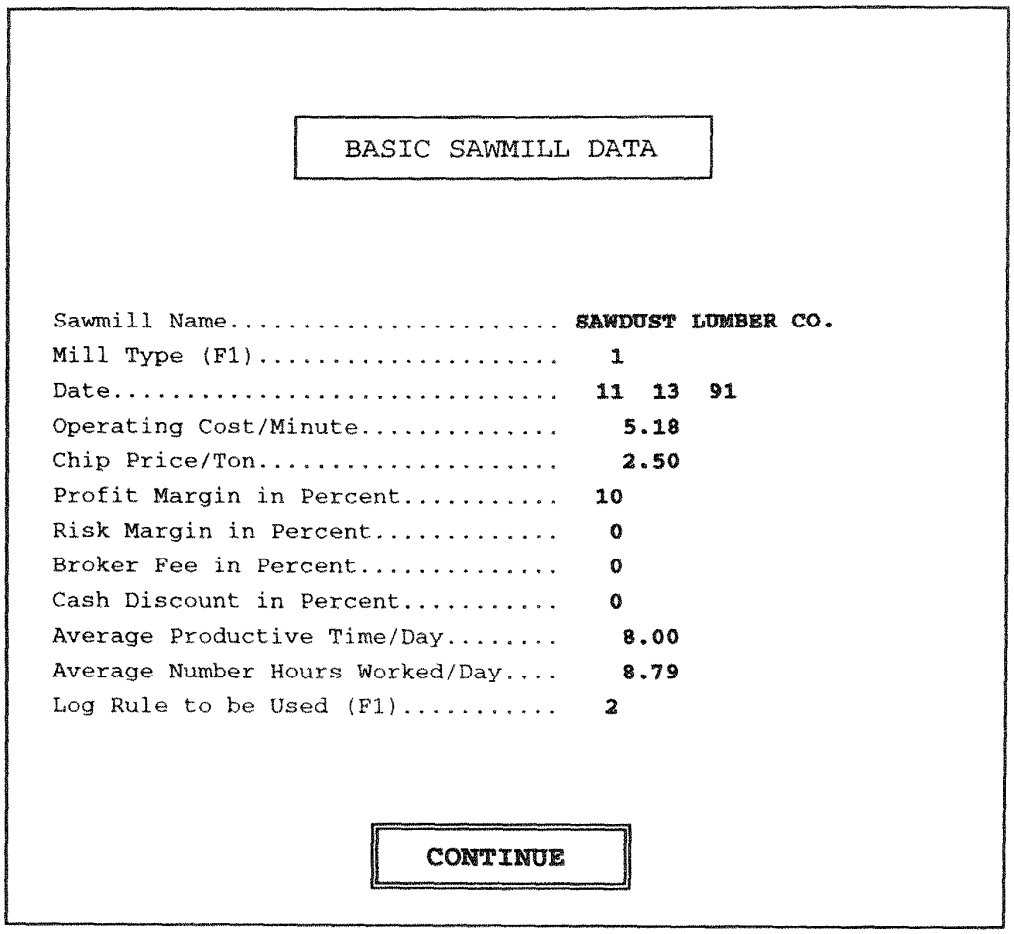

Figure 6.—Basic sawmill data form showing an example of data input.

employment security, workmen's compensation, group insurance, travel expenses, advertising, depreciation, interest, taxes, power, supplies, repairs, and maintenance. Do not include the broker fee for selling lumber in this cost, it is entered later. Also, make sure that you do not include the cost of sawlogs or the cost of other operations not directly related to the sawmill, such as logging or hauling. If part of the overhead cost is related to other operations, prorate that part pertaining to the mill.

The total yearly operating time in minutes includes the total time that the sawmill was in operation during the year. For a sawmill that works five 8-hour shifts per week, the maximum yearly operating time would be 124,800 minutes. If the mill takes a week's vacation, this figure would be reduced by 2,400 minutes. This figure would be reduced further for abnormal downtime such as when the mill is closed due to extremely cold weather, fire, or major repairs.

- Chip price/ton - the price received by the sawmill for its green chips.
- Profit margin (percent) - the mill manager's desired profit margin based on a percentage of expected sales (product value).
- Risk margin (percent) - the margin that the mill manager feels is necessary to cover the risk that occurs when logs are bought today and the lumber from those logs is sold in the future. If the lumber is air dried, this may be 6 months to 1 year later. The risk margin also is based on a percentage of sales (product value).
- Broker fee (percent) - the percentage of the lumber value paid to a lumber broker as a fee for selling the lumber.

- Cash discount (percent) - the percentage of the lumber value allowed the lumber buyer (the mill's customer) for prompt payment.
- Average productive time/day - the long-range average number of hours per day that the headsaw is actually operating. Normal downtime for things such as work breaks, saw changes, minor repairs, and minor adjustments must be reflected in this average time per day.
- Average number hours worked/day - the average number of hours that the mill operates per day. This would be 9 hours for a mill that works one 9-hour shift per day.
- Log rule to be used - code to show the log rule used by the mill. Notice that the form has the term "(F1)" following the data definition. Pressing "F1" produces a note showing the appropriate codes:
  1 - International 1/4-inch
  2 - Doyle
  3 - Scribner Decimal C
  4 - Vermont

When you are through entering or modifying data on this form, choose "CONTINUE" to return to the PC-SOLVE III INPUT form.

Basic Species Data

Figure 7 shows the form that will appear if you select one of the two data fields for "Basic Species Data" on the PC-SOLVE III INPUT form. If you were creating a new data file, the data fields would be blank. This figure represents a situation where the data file already exists and the user chose the "modify or add to" data field.

A list and discussion of the data-entry fields follow:

- Species name - species processed during the mill evaluation.
- Log grading system code - indicates whether the USFS factory log grading system is to be used in the evaluation. Notice that the form has the term "(F1)" following the data definition. Pressing "F1" produces a note showing the available codes:
  1 - USFS factory log grading system.
  0 - Any other log grading system.
- Sawing time regression code - indicates whether the sawing times are to be curved (regressed) by log grades or for all grades combined. When there are only a few size classes in each log grade, the sawing times should be curved for all grades combined due to the small sample size. Notice that the form has the term "(F1)" following the data definition. Pressing "F1" produces a note showing the appropriate codes:
  1 - Sawing times regressed for all log grades combined.
  0 - Sawing times regressed by log grade.
- Output by log-grade code - indicates whether you want the output for each log grade or for all grades combined. Notice that the form has the term "(F1)" following the data definition. Pressing "F1" produces a note showing the appropriate codes:
  1 - Output shown for all log grades combined.
  0 - Output shown by log grade.
- Log length code - indicates whether the log length measurements are to be taken to the nominal foot or nearest 0.1 foot. Notice that the form has the term "(F1)" following the data definition. Pressing "F1" produces a note showing the appropriate codes:
  1 - Log length measured to 0.1 foot.
  0 - Log length measured to the nominal foot.
- Lumber degrade factor - used to adjust for the reduction in dollar value caused by degrade and shrinkage that occurs when lumber is dried. The factor is determined by subtracting the percent loss of green lumber value from 100 percent. If the mill is selling green lumber, the factor will be 100. If the mill sells dry lumber and usually sustains a 3 percent loss in value due to degrade and shrinkage, the 3 percent would be subtracted from 100 percent to provide a lumber degrade factor of 97.
- Lumber grade titles - these are abbreviations of the lumber grades cut by the sawmill. Space is available for up to 10 lumber grades plus a special product (ties, timbers, cants, and so on). The special product is entered under grade 11. All spaces do not have to be

used. The title for each grade can have from one to four letters or numbers or a combination of both.

- Lumber prices - these are the current prices per MBF received by the mill for the different grades and thicknesses of products. The grade numbers used here correspond to the grade numbers for the grade titles discussed above. For example, if the title for FAS lumber was entered under grade 1, the prices for FAS lumber must be entered under grade 1. Special product (ties, timbers, cant, etc.) prices must be entered under lumber grade 11.

The thicknesses shown to the left of the lumber prices are in 1/4-inch units for lumber grades 1 through 10 and in inches for grade 11. In other words, a thickness of "2" represents 2/4-inch-thick lumber for lumber grades 1 through 10 and 2-inch-thick special product for grade 11. This form provides for product thicknesses up to 8 inches. What if the mill is producing 16-inch cants? This can be handled by entering the price per MBF that the mill gets for the cants under grade 11 for a thickness of 8 inches. Then the surface areas of the cants are doubled when entered as data. This is discussed further in the "Sawmill Sawlog and Lumber Yield Data" section.

When you are through entering or modifying data on this form, choose "CONTINUE" to return to the PC-SOLVE III INPUT form.

BASIC SPECIES DATA

Species Control:

Species Name.....	**WHITE OAK**
Log Grading System Code (F1).....	**1**
Sawing Time Regression Code (F1).	**1**
Output by Log Grade Code (F1)....	**1**
Log Length Code (F1).....	**1**
Lumber Degrade Factor.....	**100**

Lumber Grade Titles:

Grade No.	1	2	3	4	5	6	7	8	9	10	11
Titles	**FAS**	**1FAC**	**SELC**	**STRP**	**1COM**	**2COM**	**3COM**				**CANT**

Lumber Prices:

Thick-ness	Grade Number 1	2	3	4	5	6	7	8	9	10	11
2	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
3	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
4	**980**	**970**	**970**	**970**	**470**	**250**	**150**	**0**	**0**	**0**	**170**
5	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
6	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
7	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
8	**1275**	**1265**	**1265**	**0**	**560**	**300**	**150**	**0**	**0**	**0**	**0**

CONTINUE

Figure 7.—Basic species data form showing an example of data input.

Calculated Expected Lumber Grade Yields

Figure 8 shows the form that appears if you select the "NEW" data field for "Calculated Expected Lumber Grade Yields" on the PC-SOLVE III INPUT form (Fig. 4). The form shown in Figure 8 allows you to choose one of the 18 different species for which expected lumber grade yields are wanted. It then automatically adds them to the sawmill data file. They do not have to be entered at the keyboard. The expected yields are supplied in a data file that comes with the system. They were taken from Hanks et al. (1980). If the user wants to use expected lumber grade yields other than those provided, choose the data field for "OTHER." Once a species is chosen and "CONTINUE" is chosen, the program provides forms showing the expected yields for the selected species or provides the forms necessary for the user to enter other expected yields.

Figure 9 shows the first of three forms used for expected lumber grade yields. Data are shown for white oak. If the "OTHER" data field was chosen on the form shown in Figure 8, the data fields on this form would be blank and ready for data entry.

A discussion of the data-entry fields follows:

- Expected yield species - the species for which expected lumber grade yields are provided. Notice for this data field it says "(Press F1 to change)". If you had chosen black oak for

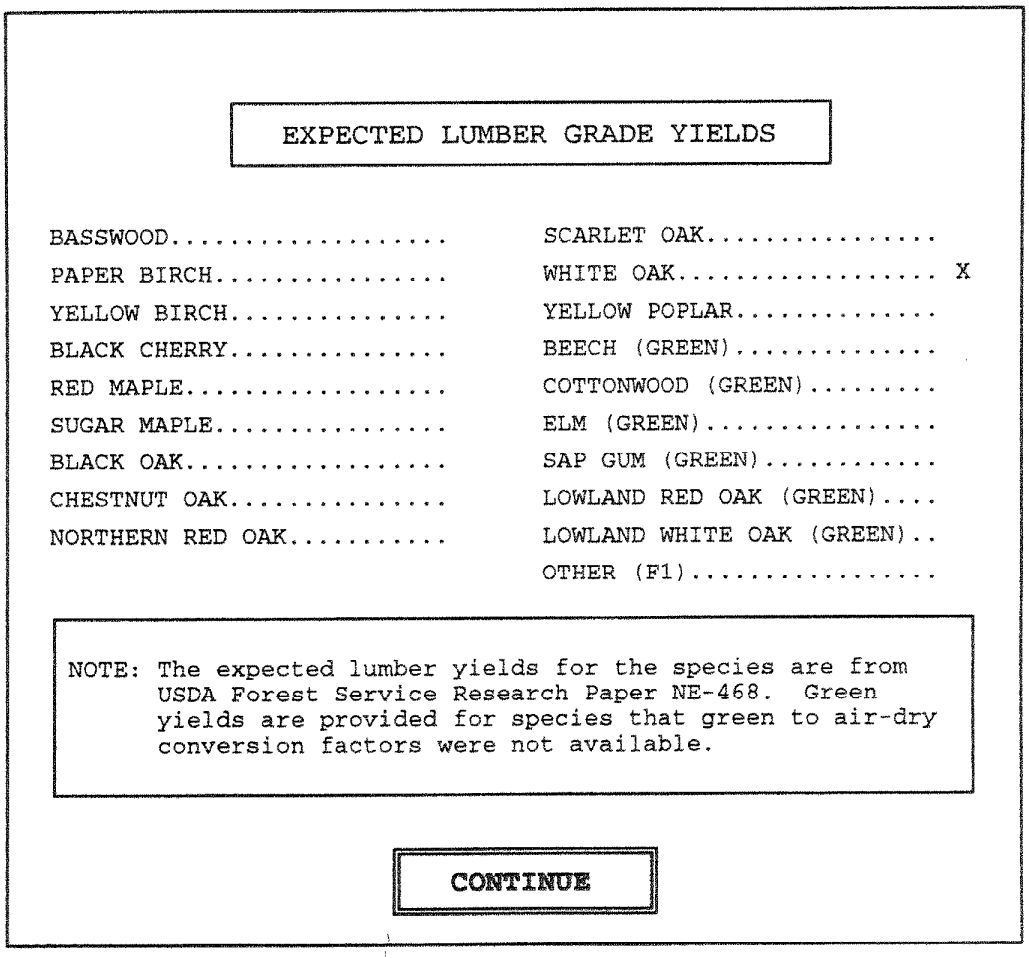

Figure 8.—Form for choosing the species for which expected lumber grade yields are desired.

expected yields but wanted to use expected yields for northern red oak, you should press "F1." A note appears stating that expected yields for a different species can be obtained by using the "SPACE BAR" to clear the species name field and then choosing "CONTINUE." The program will then return you to the form shown in Figure 7 and allow you to choose a different species.

- Expected yield code - indicates the log grades for which expected yields will be available. The codes are:

  1 - Expected lumber grade yields available.
  0 - Expected lumber grade yields not available.

- Expected lumber grade titles - these are abbreviations of the lumber grades found in the expected yields. Space is available for up to 10 lumber grades plus a special product (ties, timbers, cants, and so on). All spaces do not have to be used. The title for each grade can have from one to four letters or numbers or a combination of both. When through with this form, choose "CONTINUE" to see the expected yield for the chosen species or to enter your own expected yields.

Figure 10 shows a portion of a completed form with the expected lumber grade yields for grade 1 white oak. Because the form is not long enough to handle the yields for the full range of diameter classes found in the expected yields, a continuation form (Fig. 11) is provided. If

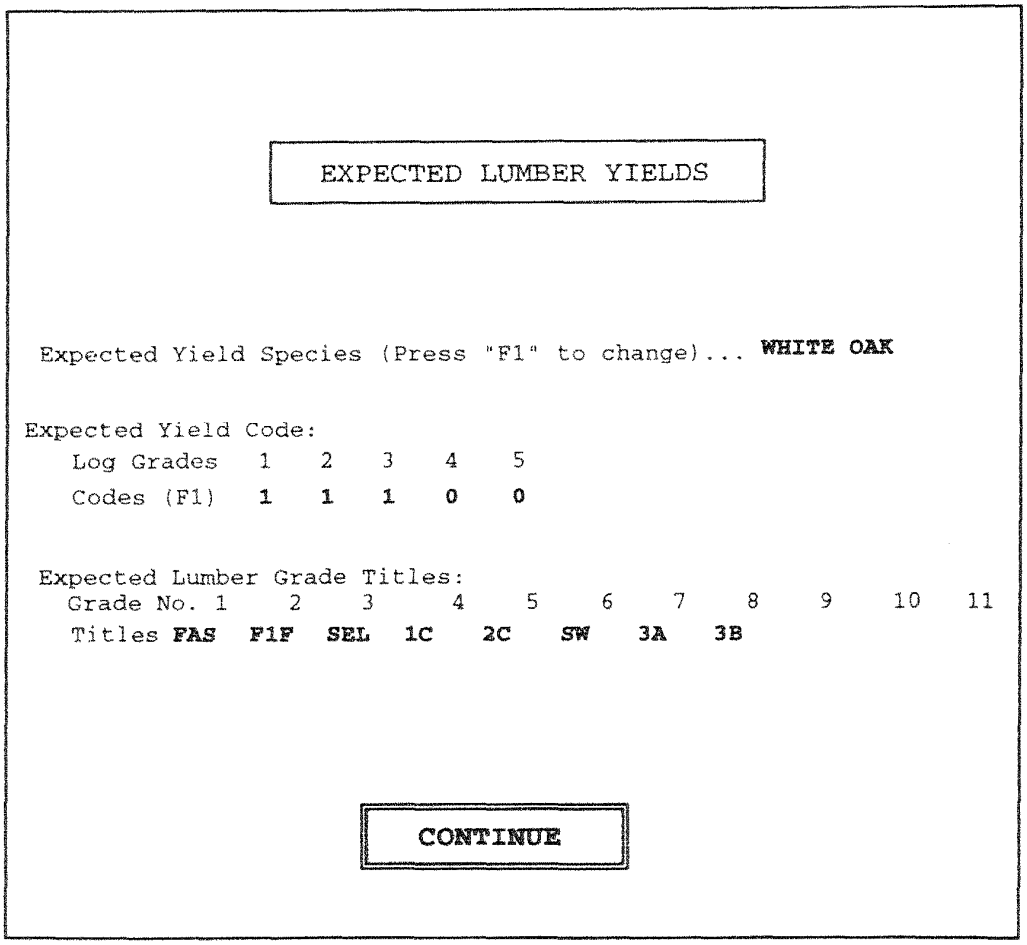

Figure 9.—Form for general information about the expected lumber grade yields to be used as input data.

yields are to be typed at the keyboard, the data fields would be blank. The entry form (Fig. 10) and the continuation form (Fig.11) are used for each log grade given an expected yield code of "1" on the form shown in Figure 9.

A discussion of the information on the forms follows:

- Species name - the species for which expected lumber grade yields are provided. The computer program automatically enters this name.
- Log grade - the log grade for which expected yields are shown or are to be entered. The computer automatically enters this.
- Lower log diameter limit - this is the smallest diameter class for which expected yields are presented or are to be entered.
- Upper log diameter limit - this is the largest diameter class for which expected yields are presented or are to be entered. When both the lower and upper diameter limits have been entered, the diameter classes are automatically entered in the expected yield table that follows.
- Logs - the number of logs, by diameter class, used to determine the expected lumber grade yields.
- Diameter class - the diameter class for which expected lumber grade yields are shown or are to be entered.

EXPECTED LUMBER YIELD DATA

Species Name..... **WHITE OAK**
Log Grade..... **GRADE 1**
Lower Log Diameter Limit... **13**
Upper Log Diameter Limit... **29**

Expected Yields (One for each diameter class):

Logs	Dia. Cla.	Lumber Tally	Lumber Grade Number 1	2	3	4	5	6	7	8	9	10	11
13	13	1234	130	133	34	302	161	32	140	68	0	0	0
10	14	1035	213	169	56	219	183	0	126	34	0	0	0
23	15	3090	153	119	33	252	208	48	126	61	0	0	0
21	16	3218	224	135	35	283	170	21	75	57	0	0	0
11	17	1933	188	107	71	222	210	71	94	37	0	0	0
13	18	2309	137	85	28	218	206	88	139	99	0	0	0
16	19	3417	154	92	33	365	211	53	71	21	0	0	0
10	20	2074	202	135	42	255	200	14	85	67	0	0	0
10	21	3074	168	151	58	282	152	32	95	62	0	0	0
9	22	2636	142	194	32	403	168	0	44	17	0	0	0

CONTINUE

Figure 10.—Form for the expected lumber grade yields by diameter class for a given log grade.

- Lumber tally - the total lumber tally volume, by diameter class, for which expected lumber grade yields are shown or are to be entered.
- Expected lumber grade yields - the expected percentage yields for up to 10 lumber grades plus a special product for each diameter class. These yield percentages must be provided for all lumber grades shown in the expected yields, even if the mill to be evaluated does not cut that lumber grade. For example, the mill may not cut a sound wormy grade when producing oak lumber. But, if the expected yields show a yield for this lumber grade, it must be entered. The yields are recorded to one decimal place. But the decimal point is not entered. A value of 14.7 percent is entered as 147.

When you are through looking at the expected yields or you have reached the end of data input, choose "CONTINUE." If the form could not display all of the expected yields for the log grade, the continuation form (Fig. 11) will appear. When you are through looking at the existing data or are through entering data, choose "CONTINUE." This process will continue until existing data have been shown or input data have been entered for all of the log grades.

Chip Yield Data

Figure 12 shows the form that will appear if you select one of the two data fields for "Chip Yield Data" on the PC-SOLVE III INPUT form. If you are creating a new data file, the data fields will be blank. This figure represents a situation where the data file already exists and the user chose the "modify or add to" data field.

EXPECTED LUMBER YIELD DATA (CONT.)

Species.... **WHITE OAK** Log Grade.... **GRADE 1**

Expected Yields (One for each diameter class):

Logs	Dia. Cla.	Lumber Tally	1	2	3	4	5	6	7	8	9	10	11
8	23	2401	170	90	46	290	249	89	44	22	0	0	0
8	24	3152	131	166	9	411	192	10	53	28	0	0	0
0	25	0	0	0	0	0	0	0	0	0	0	0	0
2	26	862	190	114	31	351	148	0	135	31	0	0	0
1	27	572	227	23	31	577	142	0	0	0	0	0	0
1	28	535	73	290	0	436	71	22	26	82	0	0	0
1	29	486	394	72	78	360	49	0	16	31	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0

CONTINUE

Figure 11.—Continuation of form shown in Figure 10 for the expected lumber grade yields by diameter class for a given log grade.

Chip yields can be obtained for up to five log grades or for all log grades combined. If chip yields are combined, the chip yield information is entered in the grade 1 section as shown in Figure 12.

A discussion of the data-entry fields follows:

- Chip yield code - indicates how chip yield data were recorded. Notice that the form has the term "(F1)" following data definition. Pressing "F1" produces a note showing the appropriate codes:
  - 2 - Chip yields are obtained by log grade.
  - 1 - Chip yields are obtained for all log grades combined.
  - 0 - Chip yields are not obtained.

- Chip yield in tons - the total green chip weight for a group of study logs.
- Lower sawing order number - the lowest sawing order number of the group of logs from which the chip weight is obtained. Sawing order numbers are discussed in the next section ("Sawmill Sawlog and Lumber Yield Data").
- Upper sawing order number - the highest sawing order number of the group of logs from which the chip weight is obtained.

When through with this form, choose "CONTINUE" to see the expected yield for the chosen species or to enter your own expected yields.

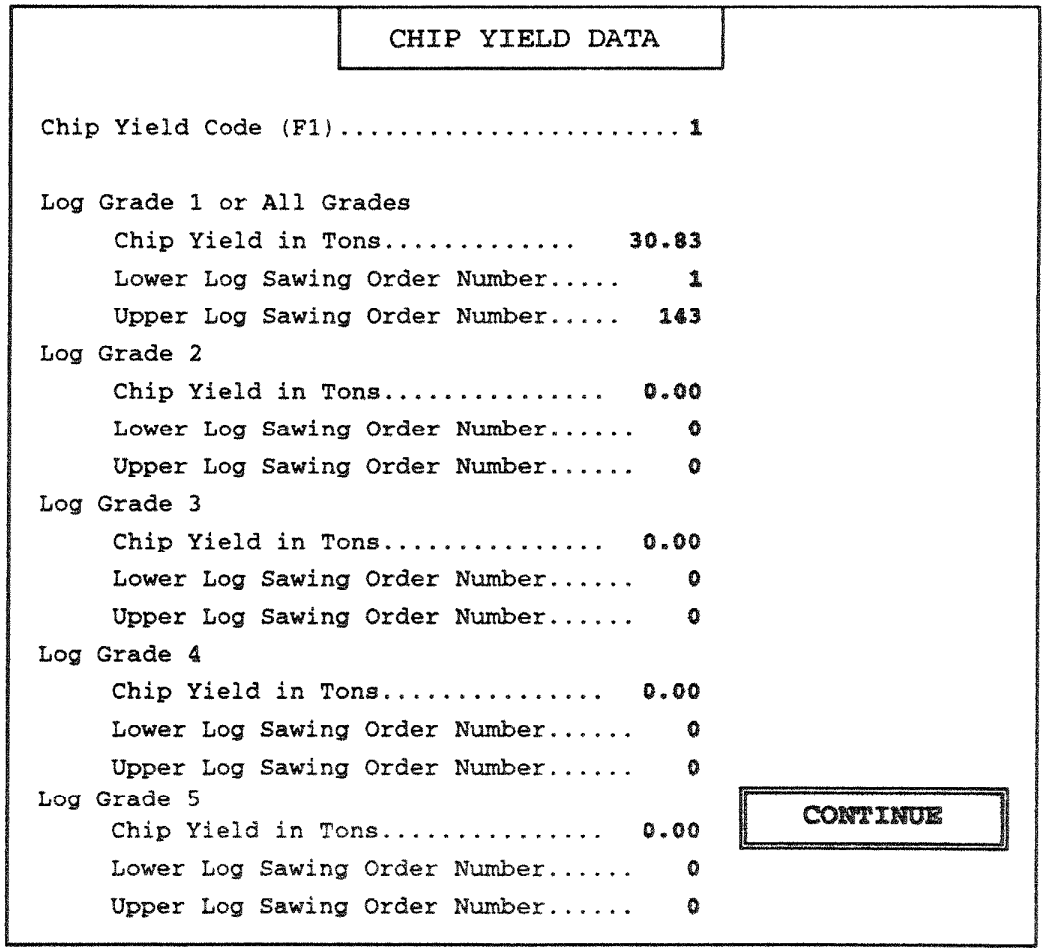

Figure 12.—Chip yield data form showing an example of data input.

Sawmill Sawlog and Lumber Yield Data

Figure 13 shows the form that will appear if you select the "NEW" data field for "Sawmill Sawlog and Lumber Yield Data" on the PC-SOLVE III INPUT form. After you have entered the required data for a study log, you are asked at the bottom of the form if there is another log. If you choose yes ("Y") and then "CONTINUE," the same form is presented again ready to receive data for the next log. Near the top of the form, the log number of the last log for which data were entered will be given. This is to help you keep track of where you are in the data entry process. When you have entered all of the log and lumber yield data or when you want to temporarily end the session, answer no ("N") to the question at the bottom of the form and choose "CONTINUE."

Figure 14 shows the form that will appear if you select the "modify or add to" data field for "Sawmill Sawlog and Lumber Yield Data" on the PC-SOLVE III INPUT form. When you choose "ADD DATA" on this form, the form shown in Figure 13 will be presented and you can continue entering data as discussed above. If you choose "MODIFY DATA" on the form shown in Figure 14, you must then enter the log number for which data are to be modified and then choose "ENTER." Another form similar to that in Figure 13 is presented along with the data for that log. You may then modify or correct any of the data on the form. The only difference from Figure 13 is that this form does not provide information on the last log number for which data were entered. When you are through modifying data for a given log, choose "CONTINUE" to return to the form shown in Figure 14. When you are through modifying data, choose "QUIT" and you will return to the PC-SOLVE III INPUT form.

SAWLOG AND LUMBER YIELD DATA

Species...... **WHITE OAK**

Log Data: Last Log Was No. **0**

Log No.	Log Grade	Small Diam.	Large Diam.	Log Length	Log Defect	Sawing Time	Sawing Order
3	**2**	**14**	**15**	**9.7**	**0**	**2.28**	**1**

Lumber Yield Data For Log No. **3** :

Th.	Gr.	Sur.	Gr.	Sur.	Gr.	Sur.	Gr.	Sur.	Gr.	Sur.	Gr.	Sur.
4	**1**	**4**	**3**	**6**	**5**	**20**	**6**	**3**	**11**	**10**	**0**	**0**
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0

Data for another log? (Y/N)...**Y**

CONTINUE

Figure 13.—Sawlog and lumber yield data form for entering new data.

A discussion of the data-entry fields shown in Figure 13 follows:

- Species - the species of sawlog used in the sawmill evaluation. This is entered automatically by the computer program.
- Last log was number - the number of the last log for which data were entered. This is automatically entered by the computer program when you are entering new log data.
- Log number - the identification number of the log for which data are being entered.
- Log grade - the grade of the sawlog.
- Small diameter - the small-end (scaling) diameter of the log in inches.
- Large diameter - the large-end diameter of the log in inches.
- Log length - the log length rounded down to the nearest 0.1 of a foot.
- Log defect - the volume defect in the log recorded in whole board feet.
- Sawing time - the sawing time for each log recorded in minutes and hundredths of minutes.
- Sawing order - indicates the order in which the logs are sawed. The logs are not usually processed in the same order as they were numbered during the log selection process. Therefore, the log number and the sawing order number are not usually the same.
- Thickness - abbreviated as "Th." on the form, the nominal lumber thickness in 1/4 inches for yields for lumber grade 1 through 10 and in inches for grade 11 (special products).
- Grade - abbreviated as "Gr." on the form, the lumber grade numbers for the lumber or special product yields to be entered. These grade numbers correspond to the grade titles entered on the "BASIC SPECIES DATA" form.
- Surface - abbreviated as "Sur." on the form, the surface measures in square feet of the lumber or special product yields being entered. Special products with thicknesses greater

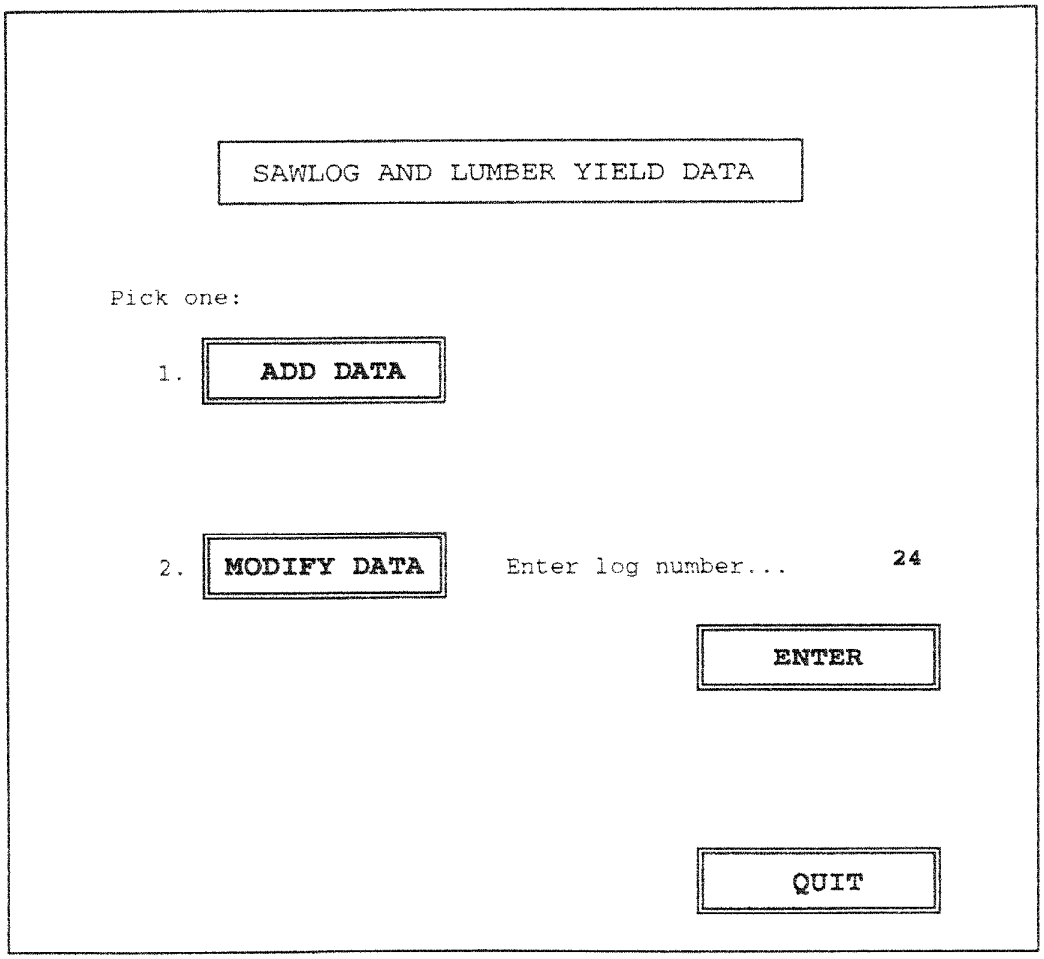

Figure 14.—Form for designating whether the user wishes to add to or modify existing sawlog and lumber yield data.

than 8 inches can be handled by adjusting the surface measure. For example, the yield of a 16-inch timber can be entered as an 8-inch timber by doubling the surface measure.

SOLVEB - Output Module 1

This section discusses the use of SOLVEB to obtain the first set of outputs (Output 1) provided by the PC-SOLVE III system. The output provides a list of the input data and a series of data summary tables.

SOLVEB consists of a batch file (SOLVEB.BAT) and two execute files (SOLVEB1.EXE and SOLVEB2.EXE). Before running the programs, make sure that a printer is connected to the computer. At the DOS prompt, type "CD SOLVE" and press "ENTER." Then, type "SOLVEB" and press "ENTER" again.

Figure 15 shows the form that appears on the screen. Notice that "(CHOICE)" follows the instruction "Enter file name." When you choose the file name data field, a list of the existing data files will appear. Choose the data file for the sawmill that you are evaluating and press "ENTER." Next, choose "CONTINUE." The system then prints the input data and the data summary information (see appendix). As the SOLVEB system runs, it also writes a data file (filename.DA2) to the hard disk that is required by SOLVEC to provide the second set of PC-SOLVE III outputs.

The first part of the output provides a list of the input data consisting of the basic mill data plus the sawlog description and yield data. This allows the sawmill analyst to check for errors that may have occurred when entering the study data at the computer keyboard. This list, when combined with the PC-SOLVE III output lists, provides a complete picture of the analysis.

The remainder of the SOLVEB output consists of several summary tables that organize the input data into a usable form. Some tables are printed to provide a more complete picture of the data. Others are printed to allow comparisons of the analysis results with published or known results.

Information available in this part of the output includes:

- Number of sample logs by diameter class for each log grade.
- Lumber tally yields by diameter class for each log grade.
- Cubic-foot log volumes by diameter class for each log grade.
- Gross log volumes for three different log rules (Doyle, Scribner Decimal C, International 1/4-inch) by diameter class for each log grade.
- Net log volume for the three different log rules by diameter class for each log grade.
- Lumber-recovery factors (LRF) by diameter class for each log grade.
- Lumber overrun for the three different log rules by diameter class for each log grade.
- Lumber grade yields by diameter class for each log grade.
- Average actual versus average expected lumber grade yields for each log grade.
- Nominal lumber thickness yields by diameter class and lumber grade for each log grade.
- Log frequency by diameter and length class for each log grade.
- Green chip yields in tons per MBF lumber tally by diameter and length class for each log grade.

SOLVEC - Output Module 2

This section discusses the use of SOLVEC to obtain the second set of outputs (Output 2) provided by PC-SOLVE III. The SOLVEC module performs regression analyses that produce equations for calculating average mill performance values by log diameter and length class. These equations are used to develop a number of output tables. This is done for each log grade in the study. The output includes tables of sawing times, product yields, processing costs, and product values for evaluating a sawmill and determining how much the mill manager can afford to pay for sawlogs. If you choose, it also provides statistics for the regressions used to develop the tables along with graphs showing plots of the data and the resulting fitted curves.

SOLVEC consists of a batch file (SOLVEC.BAT) and two execute files (SOLVEC1.EXE and SOLVEC2.EXE). Before running the programs, make sure that a printer is connected to the computer. At the DOS prompt, type "CD SOLVE" and press "ENTER." Then, enter "SOLVEC" and press "ENTER" again.

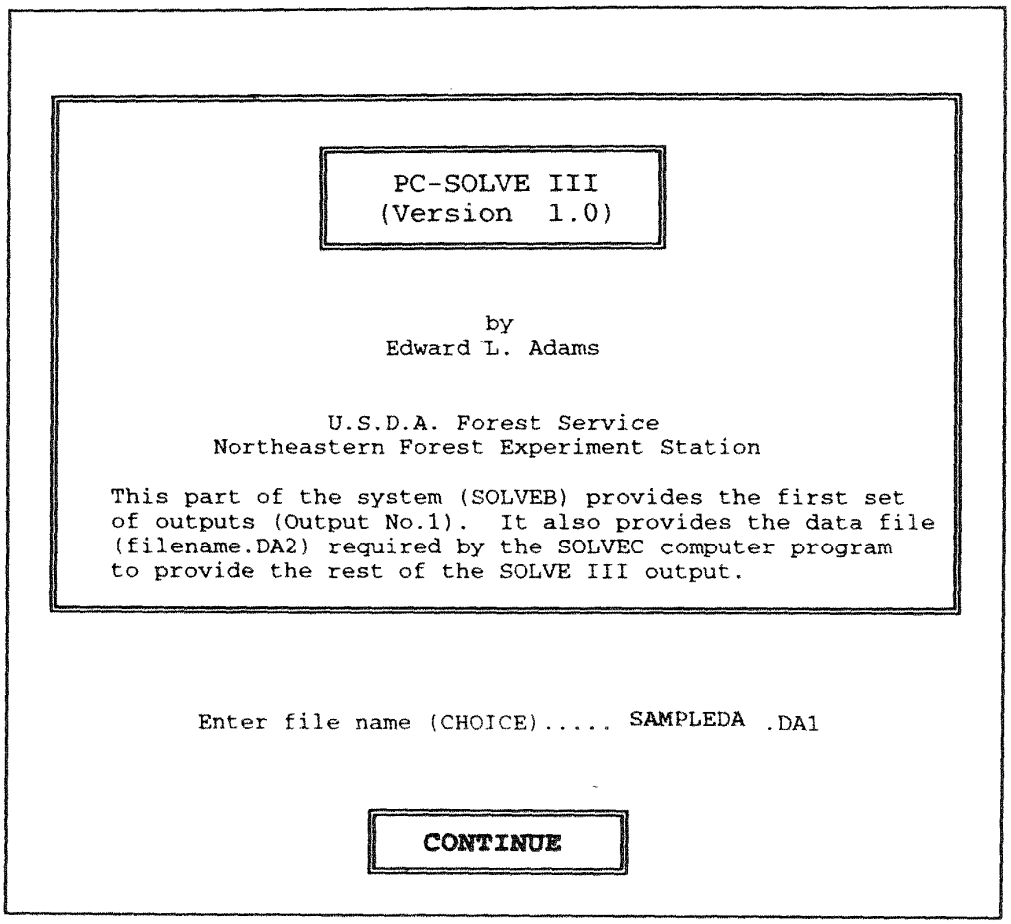

Figure 15.—Form for entering the name of the sawmill data file needed for running the SOLVEB part of PC-SOLVE III.

Figure 16 shows the form that appears on the opening SOLVEC screen. When you choose the file name data field, a list of the existing data files will appear. Choose the data file for the sawmill that you are evaluating and press "ENTER."

Next you are asked if you want statistical information included in the output. If you choose yes ("Y"), the output will provide the statistical information for the regressions used to process the data along with plots of the data and the resulting fitted curves. Finally, you are asked if you want outlying data removed during the regression process. If you choose yes ("Y"), outlying data will be removed and the regressions rerun. When you have answered the questions, choose "CONTINUE." The system then prints the output information (see appendix).

Equations are produced for several mill performance variables including:

- Sawing time per log.
- Log sawing time per MBF (lumber tally).
- Board-foot lumber yield per log.
- Board-foot lumber yield per MBF (International 1/4-inch, Scribner Decimal C, Doyle, or Vermont).
- Dollar lumber values per log.
- Dollar lumber values per MBF (lumber tally).

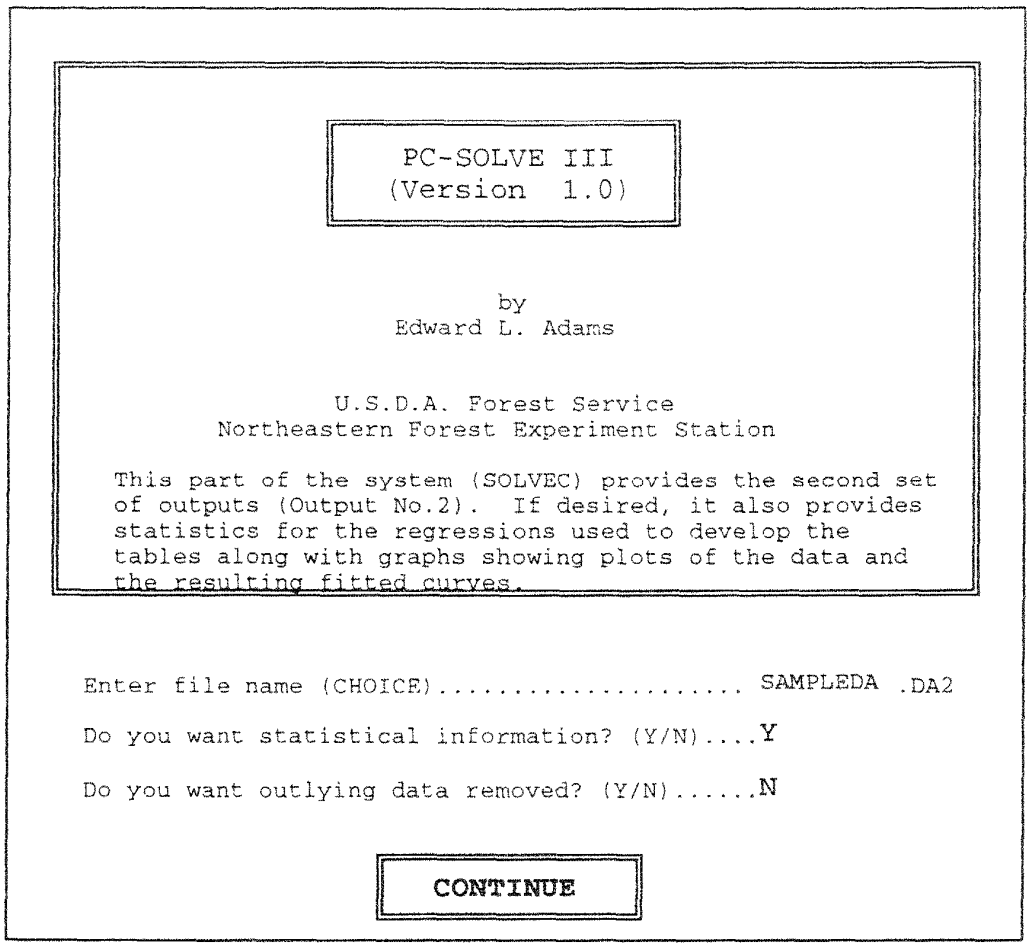

Figure 16.—Form for entering the name of the sawmill data file and choosing the run options needed to run SOLVEC.

Next, the output shows a number of tables that can be used for both noneconomic and economic evaluations of a study mill. Using the regression equations discussed above, tables are generated showing values by diameter and length classes for each log grade.

The following information is provided in SOLVEC tables:

- Lumber tally per log.
- Lumber tally per MBF (log scale).
- Lumber values in dollars per log.
- Lumber values in dollars per MBF (lumber tally).
- Chip values in dollars per log.
- Chip values in dollars per MBF (lumber tally).
- Total product values in dollars per log.
- Total product values in dollars per MBF (lumber tally).
- Sawing times in minutes per log.
- Sawing times in minutes per MBF (lumber tally).
- Conversion cost in dollars per log.
- Conversion cost in dollars per MBF (lumber tally).
- Maximum log values in dollars per MBF (log scale).
- Zero profit log values in dollars per MBF (log scale).

The term "log scale" in the above list means the log scale used by the mill being evaluated. As stated earlier, this can either be International 1/4-inch, Scribner Decimal C, Doyle, or Vermont. The values in the maximum log values table show what the mill manager can afford to pay for sawlogs for a desired profit and risk situation. The values in the zero profit log values table show what can be paid for sawlogs and just break even. If the manager pays more for a given size class of logs than the value shown in this zero profit table, money will be lost on the logs in that size class.

CONV - Data Conversion Module

This section discusses the use of program CONV to convert sawmill data files that were used with PC-SOLVE II so they can be used with PC-SOLVE III. The new converted file is written to the hard disk under the old file name (filename.DA1). A copy of the old file is retained on the hard disk with the same file name but a different extension (filename.BAK). The CONV system consists of a batch file (CONV.BAT) and two execute files (CONV1.EXE and CONV2.EXE). It is not necessary to have a printer attached to the computer to run this system. At the DOS prompt, type "CD SOLVE" and press "ENTER." Then, type "CONV" and press "ENTER" again.

Figure 17 shows the form that appears on the screen. When you choose the file name data field, a list of the existing data files will appear. Choose the data file that you want to convert and press "ENTER." Next, choose "CONTINUE." The system will then convert the data file for use with PC-SOLVE III. As discussed above, both the new file and the old file will be on the hard disk with the same file name but with different extensions.

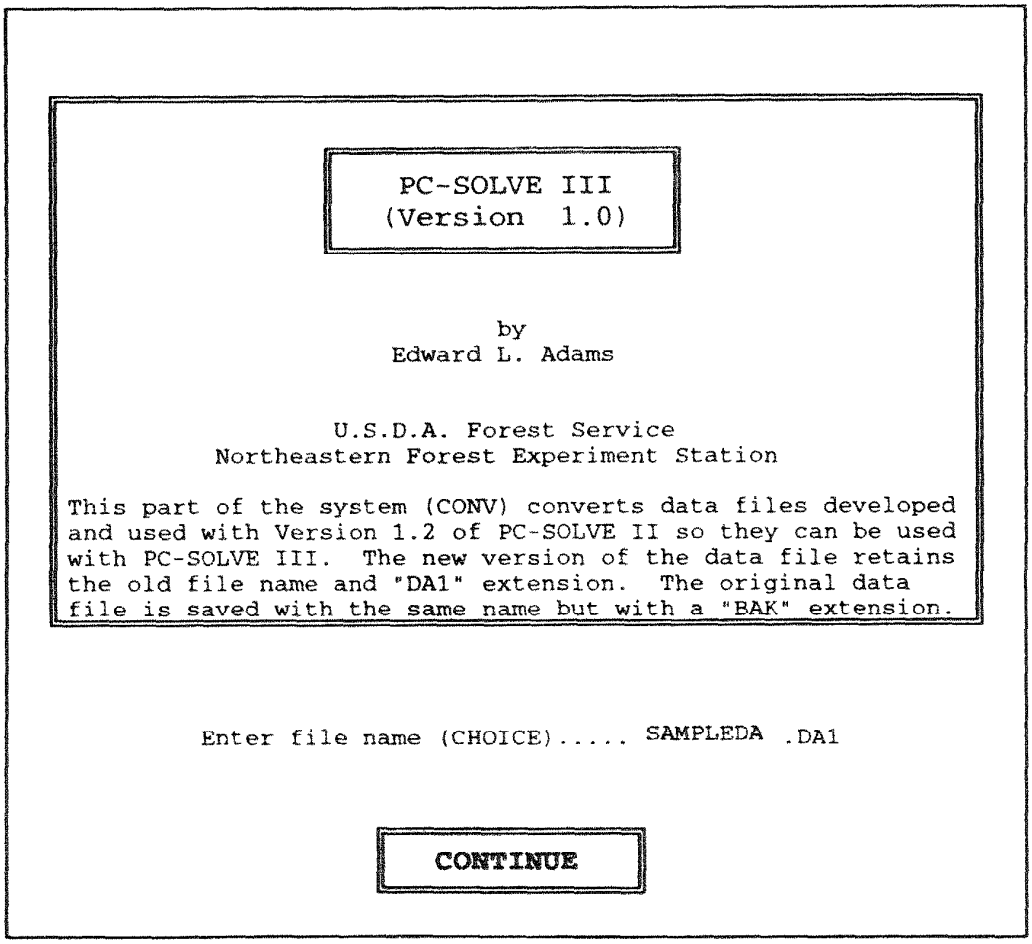

Figure 17.—Form for entering the name of the sawmill data file that is to be converted by CONV.

Output Verification and Validation

Before using the PC-SOLVE III outputs, they should be thoroughly checked to assure that they do not reflect errors in recording and/or entering data. First, the input data listing provided in the SOLVEB output should be carefully inspected. Next check the data summary tables for information that seems to be out of the normal ranges that might be expected. When satisfied that the data listing and data summary tables look good, go to the regression output.

It is crucial that the regression statistics along with their accompanying graphs are checked very carefully. This is especially true of the graphs showing plots of the data along with the resulting curved averages. A close inspection of these graphs can show where outlying data or insufficient data are adversely affecting the resulting curved averages. When this situation is detected, the log data causing the problem should be removed and the system rerun to produce new output.

After the regression outputs have been checked, check the tables provided in Output 2. Because a number of these tables are developed from the regression equations, this check also can detect problems caused by outlying and/or insufficient data. Pay particular attention to both the maximum sawlog value tables and the zero-profit log value tables. These tables are generated by using information from the other tables. Often, problems in the output that were not evident in other places will show up here.

Occasionally, what appears to be a problem may not be a problem at all. For example, in an evaluation of a mill cutting cherry logs, the maximum sawlog value tables showed that the manager could pay more for the smaller grade 3 logs than for some of the larger grade 2 logs. A close check of the regression output did not indicate that there were problems with outlying or insufficient data. However, a check of the information in Output 1 showed that the smaller grade 3 cherry logs had an unusually high yield of No. 1 Common and Better lumber. Also, the overruns for these logs were very good. The combination of high grade yields and large overruns for these logs did, in fact, make them worth more than some of the larger grade 2 logs. In questioning the individuals who collected the data, it was found that most of the smaller grade 3 logs were butt logs. They were grade 3 because of size rather than defects. This resulted in higher No. 1 Common and Better yields and overruns than would normally be found in smaller grade 3 logs. Therefore, the log values shown in the maximum sawlog value tables were correct and reflected what the manager could afford to pay for these logs. However, if at a later date the small grade 3 logs coming into the mill were not mostly butt logs, the table values would be too high. Then it would be necessary to run a new PC-SOLVE III analysis.

Using PC-SOLVE III Outputs

No attempt will be made to cover all possible uses of the PC-SOLVE III output in this discussion. Instead, we will look at how the output can be used to answer a few major questions for the mill manager:

- Is mill efficiency satisfactory?
- Are the yields by lumber grade satisfactory?
- What can the mill manager afford to pay for sawlogs for a given profit and risk situation?
- What are the sawmill's break-even log sizes?

Is Mill Efficiency Satisfactory?

Two tables in the output that help answer this question are: (1) lumber-recovery factor (LRF) by log grade and diameter class, and (2) lumber overrun by log grade and diameter class for three log rules.

The table of lumber-recovery factors (calculated by dividing the board-foot lumber yield by the cubic-foot log volume) is one measure of the efficiency of a mill. The table not only shows these factors by diameter class for each log grade, but also shows average factors for each log grade and an average factor for all grades combined. When these factors are known for different mill types, the efficiency of a particular mill can be compared with that of other mills sawing similar logs and producing similar products.

Another measure of efficiency is the lumber overrun obtained by the sawmill. Tables of percent overrun by diameter class and log grade are shown for three log rules so the mill manager can check his overrun with published or known overruns even if they are shown for a log rule different from the one used by the mill. This allows the efficiency of the study mill to be compared with other mills.

If the manager finds that the mill's lumber-recovery factor and/or overruns are lower than they should be, there are several things that can be done. First, chip yields should be checked. If they are unusually high, check to make sure that the head sawyer is not slabbing too heavily. Next, check trimming and edging practices. If these spot checks do not pinpoint the problem, it may be necessary to set up some small studies in specific areas of the sawmill. The important thing is that the mill manager's attention has been directed to a problem area.

Are the Yields by Lumber Grade Satisfactory?

To help answer this question, tables are printed that show actual yields (in percent) by lumber grade and diameter class for each log grade. If expected yields are entered as input data, the output also will show a comparison of the mill's yields with the expected yields. This comparison is based only on the log diameter classes that are found in both the actual yields and the expected yields. If the mill manager does not have expected yields for his log grades, PC-SOLVE III provides these yields for a number of different species (Hanks, et al. 1980). However, since published expected yields are presented for Forest Service (FS) log grades only, the study logs would have to be graded according to the FS standards.

If expected yields are input and it is found that the lumber grade yields (for example No. 1 Common and Better) for a given log grade are well below the expected yields, a problem may be indicated. First try to explain the difference by checking the products being produced. Special products can affect the yields in some lumber grades. If the difference cannot be explained by special products, check the practices used at the headsaw, edger, and trimmer. Finally, check the log grading and lumber-inspection practices.

What Can the Mill Afford to Pay for Sawlogs?

To help answer this question, the output provides tables showing the maximum values in dollars per MBF (log scale) by diameter and length classes for each log grade. Each of these tables also shows the average maximum price per MBF (log scale) that the mill manager could have paid for the logs used in the analysis. These maximum dollar values indicate what the manager can pay for logs and still make the desired profit.

If the manager is paying more for sawlogs than the values shown in the tables, the desired profit is not being made. To improve profitability, an attempt should be made to increase lumber recovery, reduce costs, upgrade products, or achieve some combination of these.

If the manager is paying less than the values shown in the tables, the tables can be used as a guide for buying logs. If supply is a problem, it may be possible to pay more for logs to attract a larger supply. To improve the supply of better logs, higher prices might be paid for the better logs and lower prices paid for poorer logs.

The tables of maximum sawlog values also can be used to show the effect that a change in mill operating costs or a change in product selling prices will have on what can be paid for sawlogs. So long as the products cut and the mill layout remain the same, the manager can change the price or cost data and rerun the original data to get updated table values. This can be done every time there is a significant change in prices or costs.

What are the Mill's Break-even Log Sizes?

To help answer this question, the output provides tables of zero-profit log values by diameter and length classes for each log grade. Any logs showing a negative value in these tables cost more to process than the value of the products obtained from them. These logs are usually found in the lower log grades, but may be found in the higher grades of low-value species.

By subtracting the manager's current log prices from the dollar values found in the zero-profit tables, potential dollar profit or dollar loss can be found for each log size class. A zero difference (table value same as log price) indicates that the logs in that size class are break-even logs. A positive difference indicates the potential profit for that log size; a negative difference indicates the potential loss for that log size.

A sawmill manager usually must take the logs as they come. However, if the zero-profit tables show that too many logs below the break-even sizes are being purchased, it may be advisable to consider adding equipment that can process these logs at a lower cost. Another option might be to investigate markets for products that will give a better return. Even if nothing can be done, it is important that the manager knows about the situation. Opportunities may develop in the future that will allow the situation to be corrected.

Conclusion

The PC-SOLVE III program is easier to use than earlier versions. Full-page data forms allow data to be entered or corrected without the need for additional editor software. Also, you no longer have to enter data with the computer keyboard if you wish to use expected lumber grade yields published by the USDA Forest Service.

The questions discussed in the previous section are the type that can be answered with the output provided by the system. For many questions, the output does not identify the specific problem, but it does indicate problem areas. Sometimes close observation during the data collection phase of the analysis may help pinpoint the problems. Other times, it may be necessary to return to the mill for a specific test. Even though problems may not be pinpointed, it is important to note that PC-SOLVE III allows the manager to take a good overall look at the mill operation with a minimum of effort.

Tightening mill operations and eliminating poor practices will help increase yields, reduce costs, increase production, upgrade products, and reduce residues. PC-SOLVE III can help mill managers meet these objectives.

Literature Cited

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Appendix

The Appendix shows the different types of information that can be found in the PC-SOLVE III printout. Only one example is shown for each type of information. For example, the regression analysis is shown only for sawing times per log. In a total printout, regression analyses are shown for five other types of information. Some of the tables have been abridged to save space (this is shown by arrows) and the space between them has been reduced.

SOLVEB

Input data listing

```
MILL.....SAWDUST LUMBER CO.
DATE..... 11 / 13 / 91
OPERATING COST / MINUTE..  5.18
CHIP PRICE / TON.....  2.50
DESIRED PROFIT MARGIN....   10
NECESSARY RISK MARGIN....    0
BROKER FEE.....    0
CASH DISCOUNT.....    0
AVE. PROD. TIME / DAY....  8.00
AVE. HOURS WORK / DAY....  8.79
MILL TYPE CODE.....  1
```

LUMBER PRICES
SPECIES - WHITE OAK

THICK -NESS	FAS	1FAC	SELC	STRP	LUMBER GRADE 1COM	2COM	3COM				CANT
2/4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3/4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4/4	980.	970.	970.	970.	470.	250.	150.	0.	0.	0.	170.
5/4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
6/4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
7/4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
8/4	1275.	1265.	1265.	0.	560.	300.	150.	0.	0.	0.	0.

RAW LUMBER YIELD DATA

LOG NO.	LOG GRADE	SMALL DIAM.	LARGE DIAM.	LOG LGTH	LOG DEP.	SPECIES			SAWING TIME			SAWING ORDER		
	BOARD THICK	LBR GRD	SURF MEAS	LBR GRD	SURF MEAS	LBR GRD	SURF MEAS		LBR GRD	SURF MEAS		LBR GRD	SURF MEAS	
3	2	14.	15.	9.7	0.	WHITE OAK			2.28			1		
	4.	1	4.	3	6.	5	20.		6	3.	11	10.	0.	0.
2	2	15.	16.	10.4	0.	WHITE OAK			2.35			2		
	4.	1	5.	2	22.	3	4.		5	11.	6	5.	11	10.
	8.	2	8.	0	0.	0	0.		0	0.	0	0.	0	0.
1	2	16.	17.	8.4	0.	WHITE OAK			2.13			3		
	4.	2	9.	3	12.	4	2.		5	10.	6	6.	11	10.
6	2	15.	16.	8.1	0.	WHITE OAK			2.32			4		
	4.	2	8.	3	12.	5	20.		6	11.	11	4.	0	0.

Data summary tables

DIAM. CLASS	WHITE OAK NO OF LOGS BY LOG GRADE 1	2	3	4	5	DIAM TOTL
11	0	1	0	0	0	1
12	0	1	0	0	0	1
13	0	2	0	0	0	2
14	0	7	1	0	0	8
15	1	7	1	0	0	9
16	0	7	2	0	0	9
17	3	11	3	0	0	17
18	6	16	4	0	0	26
19	2	18	1	0	0	21
20	1	10	2	0	0	13
21	3	8	1	0	0	12
22	2	4	1	0	0	7
23	1	6	0	0	0	7
24	2	1	0	0	0	3
25	0	1	0	0	0	1
26	1	2	0	0	0	3
27	0	2	0	0	0	2
28	0	1	0	0	0	1
GRADE TOTL	22	105	16	0	0	143

WHITE OAK
BF LUMBER TALLY BY LOG GRADE

DIAM. CLASS	1	2	3	4	5	DIAM. TOTL
11	0	40	0	0	0	40
12	0	35	0	0	0	35
13	0	127	0	0	0	127
14	0	599	71	0	0	670
15	165	597	103	0	0	865
16	0	822	195	0	0	1017
17	455	1345	343	0	0	2143
18	1020	2137	719	0	0	3876
19	324	2540	194	0	0	3058
20	192	1657	335	0	0	2184
21	813	1344	223	0	0	2380
22	480	729	156	0	0	1365
23	215	1266	0	0	0	1481
24	497	287	0	0	0	784
25	0	257	0	0	0	257
26	454	654	0	0	0	1108
27	0	498	0	0	0	498
28	0	518	0	0	0	518
GRADE TOTL	4615	15452	2339	0	0	22406

WHITE OAK
CUBIC FT. LOG VOLUME BY LOG GRADE

DIAM. CLASS	1	2	3	4	5	DIAM. TOTL
11	.000	7.175	.000	.000	.000	7.175
12	.000	8.252	.000	.000	.000	8.252
13	.000	19.164	.000	.000	.000	19.164
14	.000	91.103	10.601	.000	.000	101.704
15	26.208	89.508	13.511	.000	.000	129.227
16	.000	118.818	28.685	.000	.000	147.503
17	92.077	196.450	54.005	.000	.000	342.532
18	196.430	326.557	97.913	.000	.000	620.900
19	55.660	413.292	25.526	.000	.000	494.479
20	27.482	264.931	54.137	.000	.000	346.551
21	158.182	208.309	31.280	.000	.000	397.771
22	74.657	118.339	22.653	.000	.000	215.648
23	40.227	207.484	.000	.000	.000	247.711
24	90.125	49.107	.000	.000	.000	139.232
25	.000	36.425	.000	.000	.000	36.425
26	69.311	110.360	.000	.000	.000	179.671
27	.000	78.992	.000	.000	.000	78.992
28	.000	85.301	.000	.000	.000	85.301
GRADE TOTL	830.360	2429.566	338.310	0	0	3598.236

WHITE OAK
GRS LOG VOL DOYLE BY LOG GRADE

DIAM. CLASS	1	2	3	4	5	DIAM. TOTL
11	0	24	0	0	0	24
12	0	32	0	0	0	32
13	0	97	0	0	0	97
14	0	443	50	0	0	493
15	121	475	76	0	0	672
16	0	657	171	0	0	828
17	411	1066	326	0	0	1803
18	894	1811	575	0	0	3280
19	281	2349	169	0	0	2799
20	176	1600	320	0	0	2096
21	777	1390	217	0	0	2384
22	445	709	162	0	0	1316
23	203	1352	0	0	0	1555
24	500	300	0	0	0	800
25	0	220	0	0	0	220
26	423	756	0	0	0	1179
27	0	562	0	0	0	562
28	0	576	0	0	0	576
GRADE TOTL	4231	14419	2066	0	0	20716

WHITE OAK
GRS LOG VOL SCRIB.C BY LOG GRADE

DIAM. CLASS	1	2	3	4	5	DIAM. TOTL
11	0	30	0	0	0	30
12	0	40	0	0	0	40
13	0	110	0	0	0	110
14	0	510	60	0	0	570
15	140	560	90	0	0	790
16	0	730	190	0	0	920
17	440	1170	350	0	0	1960
18	970	1990	620	0	0	3580
19	300	2480	180	0	0	2960
20	190	1740	350	0	0	2280
21	820	1460	230	0	0	2510
22	460	740	170	0	0	1370
23	210	1410	0	0	0	1620
24	510	300	0	0	0	810
25	0	230	0	0	0	230
26	440	780	0	0	0	1220
27	0	580	0	0	0	580
28	0	580	0	0	0	580
GRADE TOTL	4480	15440	2240	0	0	22160

WHITE OAK

GRS LOG VOL INT 1/4 BY LOG GRADE

DIAM. CLASS	1	2	3	4	5	DIAM. TOTL
11	0	35	0	0	0	35
12	0	45	0	0	0	45
13	0	130	0	0	0	130
14	0	575	65	0	0	640
15	160	595	95	0	0	850
16	0	795	205	0	0	1000
17	490	1235	380	0	0	2105
18	1035	2060	665	0	0	3760
19	315	2610	190	0	0	3115
20	195	1740	345	0	0	2280
21	855	1505	235	0	0	2595
22	475	745	170	0	0	1390
23	210	1410	0	0	0	1620
24	515	310	0	0	0	825
25	0	220	0	0	0	220
26	435	775	0	0	0	1210
27	0	555	0	0	0	555
28	0	585	0	0	0	585
GRADE TOTL	4685	15925	16	0	0	22960

WHITE OAK

NET LOG VOL DOYLE BY LOG GRADE

DIAM. CLASS	1	2	3	4	5	DIAM. TOTL
11	0	24	0	0	0	24
12	0	32	0	0	0	32
13	0	97	0	0	0	97
14	0	443	50	0	0	493
15	121	475	76	0	0	672
16	0	657	171	0	0	828
17	411	1066	326	0	0	1803
18	894	1811	575	0	0	3280
19	281	2349	169	0	0	2799
20	176	1600	320	0	0	2096
21	777	1390	217	0	0	2384
22	445	709	162	0	0	1316
23	203	1352	0	0	0	1555
24	500	300	0	0	0	800
25	0	220	0	0	0	220
26	423	713	0	0	0	1136
27	0	562	0	0	0	562
28	0	576	0	0	0	576
GRADE TOTL	4231	14376	2066	0	0	143

WHITE OAK

NET LOG VOL SCRIB.C BY LOG GRADE

DIAM. CLASS	1	2	3	4	5	DIAM. TOTL
11	0	30	0	0	0	30
12	0	40	0	0	0	40
13	0	110	0	0	0	110
14	0	510	60	0	0	570
15	140	560	90	0	0	790
16	0	730	190	0	0	920
17	440	1170	350	0	0	1960
18	970	1990	620	0	0	3580
19	300	2480	180	0	0	2960
20	190	1740	350	0	0	2280
21	820	1460	230	0	0	2510
22	460	740	170	0	0	1370
23	210	1410	0	0	0	1620
24	510	300	0	0	0	810
25	0	230	0	0	0	230
26	440	737	0	0	0	1177
27	0	580	0	0	0	580
28	0	580	0	0	0	580
GRADE TOTL	4480	15397	2240	0	0	22117

WHITE OAK

NET LOG VOL INT 1/4 BY LOG GRADE

DIAM. CLASS	1	2	3	4	5	DIAM. TOTL
11	0	35	0	0	0	35
12	0	45	0	0	0	45
13	0	130	0	0	0	130
14	0	575	65	0	0	640
15	160	595	95	0	0	850
16	0	795	205	0	0	1000
17	490	1235	380	0	0	2105
18	1035	2060	665	0	0	3760
19	315	2610	190	0	0	3115
20	195	1740	345	0	0	2280
21	855	1505	235	0	0	2595
22	475	745	170	0	0	1390
23	210	1610	0	0	0	1620
24	515	310	0	0	0	825
25	0	220	0	0	0	220
26	435	732	0	0	0	1167
27	0	555	0	0	0	555
28	0	585	0	0	0	585
GRADE TOTL	4685	15882	2350	0	0	22917

WHITE OAK

LUMBER RECOV. FACT. BY LOG GRADE

DIAM. CLASS	1	2	3	4	5	DIAM. AVE
11	.000	5.575	.000	.000	.000	5.575
12	.000	4.262	.000	.000	.000	4.262
13	.000	6.627	.000	.000	.000	6.627
14	.000	6.575	6.698	.000	.000	6.588
15	6.296	6.670	7.624	.000	.000	6.696
16	.000	6.918	6.798	.000	.000	6.895
17	4.942	6.847	6.351	.000	.000	6.256
18	5.193	6.544	7.343	.000	.000	6.263
19	5.821	6.146	7.600	.000	.000	6.186
20	6.986	6.254	6.188	.000	.000	6.302
21	5.140	6.452	7.129	.000	.000	5.983
22	6.429	6.160	6.887	.000	.000	6.330
23	5.345	6.102	.000	.000	.000	5.979
24	5.515	5.844	.000	.000	.000	5.631
25	.000	7.056	.000	.000	.000	7.056
26	6.550	5.926	.000	.000	.000	6.167
27	.000	6.306	.000	.000	.000	6.306
28	.000	6.073	.000	.000	.000	6.073
GRADE TOTL	5.558	6.360	6.914	0	0	6.227

WHITE OAK

OVER RUN DOYLE BY LOG GRADE

DIAM. CLASS	1	2	3	4	5	DIAM. AVE
11	.0	66.7	.0	.0	.0	66.7
12	.0	9.4	.0	.0	.0	9.4
13	.0	30.9	.0	.0	.0	30.9
14	.0	35.2	62.0	.0	.0	35.9
15	36.0	25.7	35.5	.0	.0	28.7
16	.0	25.1	14.0	.0	.0	22.8
17	10.7	26.2	5.2	.0	.0	18.9
18	14.1	18.0	25.8	.0	.0	18.2
19	15.3	8.1	14.8	.0	.0	9.3
20	9.1	3.6	4.7	.0	.0	4.2
21	4.6	-3.3	2.8	.0	.0	-.2
22	7.9	2.8	-3.7	.0	.0	3.7
23	5.9	-6.4	.0	.0	.0	-4.8
24	-.6	-4.3	.0	.0	.0	-2.0
25	.0	16.8	.0	.0	.0	16.8
26	7.3	-8.3	.0	.0	.0	-2.5
27	.0	-11.4	.0	.0	.0	-11.4
28	.0	-10.1	.0	.0	.0	-10.1
GRADE TOTL	9.1	7.5	13.2	0	0	8.4

WHITE OAK

OVER RUN SCRIB.C BY LOG GRADE

DIAM. CLASS	1	2	3	4	5	DIAM. AVE
11	.0	33.3	.0	.0	.0	33.3
12	.0	-12.5	.0	.0	.0	-12.5
13	.0	15.5	.0	.0	.0	15.5
14	.0	17.5	18.3	.0	.0	17.5
15	17.9	6.6	14.4	.0	.0	9.5
16	.0	12.6	2.6	.0	.0	10.5
17	3.4	15.0	-2.0	.0	.0	9.3
18	5.2	7.4	16.0	.0	.0	8.3
19	8.0	2.4	7.8	.0	.0	3.3
20	1.1	-4.8	-4.3	.0	.0	-4.2
21	-.9	-7.9	-3.0	.0	.0	-5.2
22	4.3	-1.5	-8.2	.0	.0	-.4
23	2.4	-10.2	.0	.0	.0	-8.6
24	-2.5	-4.3	.0	.0	.0	-3.2
25	.0	11.7	.0	.0	.0	11.7
26	3.2	-11.3	.0	.0	.0	-5.9
27	.0	-14.1	.0	.0	.0	-14.1
28	.0	-10.7	.0	.0	.0	-10.7
GRADE TOTL	3.0	.4	4.4	0	0	1.3

WHITE OAK

OVER RUN INT 1/4 BY LOG GRADE

DIAM. CLASS	1	2	3	4	5	DIAM. AVE
11	.0	14.3	.0	.0	.0	14.3
12	.0	-22.2	.0	.0	.0	-22.2
13	.0	-2.3	.0	.0	.0	-2.3
14	.0	4.2	9.2	.0	.0	4.7
15	3.1	.3	8.4	.0	.0	1.8
16	.0	3.4	-4.9	.0	.0	1.7
17	-7.1	8.9	-9.7	.0	.0	1.8
18	-1.4	3.7	8.1	.0	.0	3.1
19	2.9	-2.7	2.1	.0	.0	-1.8
20	-1.5	-4.8	-2.9	.0	.0	-4.2
21	-4.9	-10.7	-5.1	.0	.0	-8.3
22	1.1	-2.1	-8.2	.0	.0	-1.8
23	2.4	-10.2	.0	.0	.0	-8.6
24	-3.5	-7.4	.0	.0	.0	-5.0
25	.0	16.8	.0	.0	.0	16.8
26	4.4	-10.7	.0	.0	.0	-5.1
27	.0	-10.3	.0	.0	.0	-10.3
28	.0	-11.5	.0	.0	.0	-11.5
GRADE TOTL	-1.5	-2.7	-.5	0	0	-2.2

The following SOLVEB and SOLVEC outputs are shown for each log grade included in the input data.

WHITE OAK

LUMBER GRADE YIELD FOR LOG GRADE 1 IN PERCENT

DIAM. CLASS	NO. LOGS	LUMBER TALLY	LUMBER GRADES FAS	1FAC	SELC	STRP	1COM	2COM	3COM			CANT
15	1.	165.	30.9	12.1	.0	2.4	1.8	.0	9.1	.0	.0	.0 43.6
16	0.	0.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0 .0
17	3.	455.	29.5	30.8	7.7	1.1	4.4	5.5	3.5	.0	.0	.0 17.6
18	6.	1020.	22.5	24.1	4.3	.4	12.5	6.2	3.6	.0	.0	.0 26.3
19	2.	324.	20.7	20.1	1.9	.9	8.0	8.3	10.5	.0	.0	.0 29.6
20	1.	192.	27.6	15.6	6.3	.0	6.8	.0	18.8	.0	.0	.0 25.0
21	3.	813.	45.4	11.8	2.8	4.2	4.7	2.7	9.2	.0	.0	.0 19.2
22	2.	480.	56.3	12.1	4.6	.8	1.3	.0	4.2	.0	.0	.0 20.8
23	1.	215.	31.6	31.6	4.2	4.2	.0	7.0	2.8	.0	.0	.0 18.6
24	2.	497.	32.2	26.4	7.2	.8	11.9	4.0	3.0	.0	.0	.0 14.5
25	0.	0.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0 .0
26	1.	454.	67.4	2.9	3.5	.0	.7	3.1	8.4	.0	.0	.0 14.1
AVE.	22.	4615.	37.0	18.8	4.4	1.5	6.4	4.0	6.3	.0	.0	.0 21.6

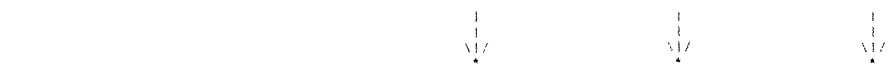
ACT. VS. EXP. LUMBER GRADE YIELDS IN PERCENT
LOG GRADE 1

	DIAM. RANGE	NO. LOGS	LUMBER GRADE FAS	1FAC	SELC	STRP	1COM	2COM	3COM			CANT
ACT. AVE.	15- 26	22	37.0	18.8	4.4	1.5	6.4	4.0	6.3	.0	.0	.0 21.6

	DIAM. RANGE	NO. LOGS	LUMBER GRADE FAS	F1F	SEL	1C	2C	SW	3A	3B		
EXP. AVE.	15- 26	131	16.7	12.8	3.7	30.6	19.3	3.9	8.3	4.6	.0	.0 .0

LUMBER THICKNESS YIELD FOR LOG GRADE 1 IN PERCENT

DI. TH.	FAS	1FAC	SELC	STRP	LUMBER GRADES 1COM	2COM	3COM				CANT	AVE.
15												
2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
4	72.5	30.0	.0	100.0	100.0	.0	100.0	.0	.0	.0	100.0	83.0
5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
8	27.5	70.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	17.0
16												
2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
17												
2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
4	28.4	44.3	48.6	100.0	100.0	60.0	100.0	.0	.0	.0	100.0	55.6



5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
16												
2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
4	4.6	100.0	50.0	.0	100.0	100.0	100.0	.0	.0	.0	100.0	33.9
5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
8	95.4	.0	50.0	.0	.0	.0	.0	.0	.0	.0	.0	66.1
AVE												
2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
4	24.5	42.1	56.7	100.0	89.2	83.9	93.2	.0	.0	.0	100.0	57.5
5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
8	75.5	57.9	43.3	.0	10.8	16.1	6.8	.0	.0	0	.0	42.5

WHITE OAK
LOG FREQUENCY DISTRIBUTION (PERCENT)
BY LOG LENGTH AND DIAMETER
LOG GRADE 1

LOG DIAM.	LOG LENGTH 6	8	10	12	14	16	18	AVE.
15	.00	.00	.00	.00	.00	4.55	.00	4.55
16	.00	.00	.00	.00	.00	.00	.00	.00
17	.00	4.55	.00	.00	4.55	4.55	.00	13.64
18	.00	.00	9.09	13.64	.00	4.55	.00	27.27
19	.00	4.55	.00	4.55	.00	.00	.00	9.09
20	.00	.00	4.55	.00	.00	.00	.00	4.55
21	.00	.00	.00	9.09	.00	4.55	.00	13.64
22	.00	.00	4.55	4.55	.00	.00	.00	9.09
23	.00	4.55	.00	.00	.00	.00	.00	4.55
24	.00	4.55	4.55	.00	.00	.00	.00	9.09
25	.00	.00	.00	.00	.00	.00	.00	.00
26	.00	.00	.00	.00	4.55	.00	.00	4.55
AVE.	.00	18.18	22.73	31.82	9.09	18.18	.00	

WHITE OAK
CHIP YIELD PER MBF (LUMBER TALLY)
BY LOG LENGTH AND DIAMETER
LOG GRADE 1

LOG DIAM.	LOG LENGTH 8	10	12	14	16
15	1.80	1.62	1.51	1.43	1.37
16	1.70	1.54	1.44	1.37	1.32
17	1.61	1.48	1.39	1.33	1.29
18	1.54	1.42	1.35	1.29	1.25
19	1.48	1.38	1.31	1.26	1.23
20	1.43	1.34	1.28	1.24	1.21
21	1.39	1.31	1.25	1.21	1.19
22	1.36	1.28	1.23	1.20	1.17
23	1.32	1.26	1.21	1.18	1.16
24	1.30	1.23	1.19	1.16	1.14
25	1.27	1.22	1.18	1.15	1.13
26	1.25	1.20	1.17	1.14	1.12

SOLVEC

Regression information

The following information and graph also are given for sawing time/MBF, lumber yield/log, lumber yield/MBF, dollar yield/log, and dollar yield/MBF.

```
                    SAWDUST LUMBER CO.
                    SPECIES - WHITE OAK
                    LOG GRADE 1
                    SAWING TIME / LOG
                    EQUATION NO. 1

LEAST SQUARES SOLUTION -- Y=B0+(B1*X1)+(B2*X2)

                              Y = SAWING TIME / LOG (MINUTES)
                              X1 = LOG DIAMETER (INCHES)
                              X2 = X1 SQUARED X LOG LENGTH (FEET)

                        ANALYSIS OF VARIANCE

SOURCE        DF          SS              MS              F

CONST.         1        365.9760        365.9760        451.3940
  X1           1         13.2209         13.2209         16.3066
  X2           1          2.7958          2.7958          3.4483
 RES.         19         15.4046           .8108
TOTAL         22        397.3973

                      CORRELATION COEFFICIENTS

          CORRELATION COEFFICIENT (X1,Y) =  .64866
          CORRELATION COEFFICIENT (X2,Y) =  .68440
          CORRELATION COEFFICIENT (X1,X2)=  .75196
          MULT. CORRELATION COEFF.( R ) =  .71396
          COEFF. OF DETERMINATION (R**2) =  .50974

                      REGRESSION COEFFICIENTS

STANDARD ERROR

          B0 =          .26012
          B1 =          .13447          .10625
          B2 =          .00035          .00019

          STANDARD ERROR OF ESTIMATE =      .90043

          EQUATION NO. 1

               Y =    -.26012 + (    .13447 * X1 ) + (    .00035 * X2)


                    SAWDUST LUMBER CO.
                    SPECIES - WHITE OAK
                    LOG GRADE 1
                    SAWING TIME / LOG

EQUATION NO. 1

LEAST SQUARES SOLUTION -- Y=B0+(B1*X1)+(B2X2)

                              Y = SAWING TIME / LOG (MINUTES)
                              X1 = LOG DIAMETER (INCHES)
                              X2 = X1 SQUARED X LOG LENGTH (FEET)

OBSERVED AND PREDICTED VALUES

OBS.  LOG   LOG    LOG     OBSERVED     PREDICED     RESIDUALS
NO.   NO.  DIAM.  LGTH        Y            Y

  1     5   19.     8.     3.32000      3.30286      -.01714
  2     7   17.     8.     2.37000      2.83287       .46287
  3    12   18.    12.     3.24000      3.51742       .27742
  4    14   18.    12.     4.15000      3.51742      -.63258
  5    32   23.     9.     4.16000      4.49449       .33449
  6    39   26.    14.     5.17000      6.53943      1.36943
  7    45   15.    16.     2.57000      3.01349       .44349
  8    51   19.    12.     4.08000      3.80687      -.27313
  9    91   22.    10.     3.29000      4.38759      1.09759
 10    98   20.    11.     3.11000      3.96507       .85507
 11   102   17.    16.     3.58000      3.63984       .05984
 12   105   18.    16.     4.07000      3.96978      -.10022
 13   107   22.    12.     4.21000      4.72546       .51546
 14   109   18.    10.     4.13000      3.29125      -.83875
 15   108   21.    17.     5.52000      5.18051      -.33949
 16   110   18.    12.     3.31000      3.51742       .20742
 17   117   24.    11.     8.06000      5.17869     -2.88131
 18   118   21.    13.     5.17000      4.56481      -.60519
 19   122   21.    13.     5.18000      4.56481      -.61519
 20   133   24.     9.     4.23000      4.77660       .54660
 21   134   17.    15.     3.58000      3.53897      -.04103
 22   137   18.    11.     3.23000      3.40434       .17434
```

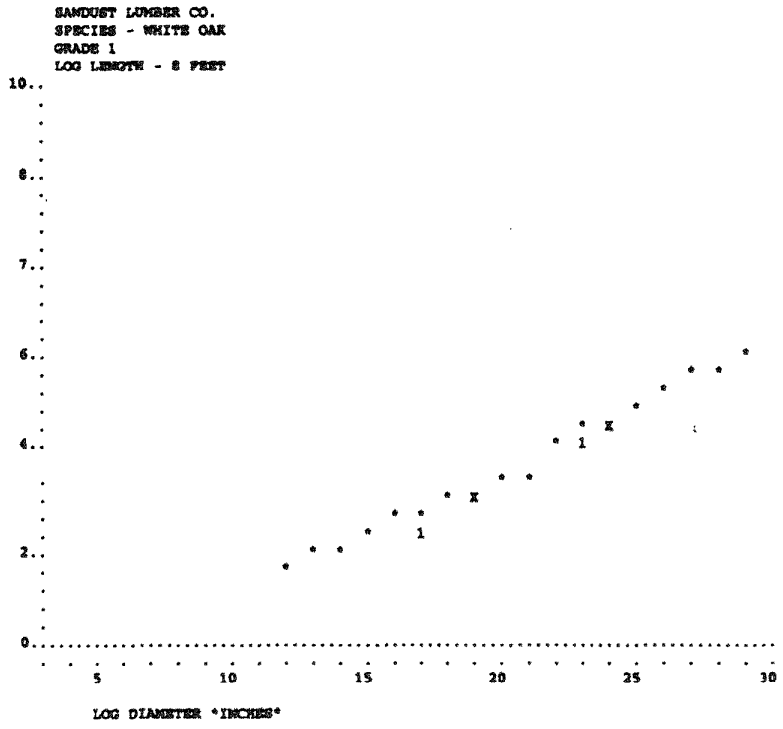
RESIDUAL CHECK FOR OUTLYING DATA

UPPER LIMIT (+4 STAND. DEV.) = 3.34714

LOWER LIMIT (-4 STAND. DEV.) = -3.34714

OUTLYING RESIDUALS

OBSERVATION	RESIDUAL
NONE	NONE



Yield and value tables (based on regression equations)

SAWDUST LUMBER CO.

CURVED LUMBER TALLY
(VOLUME / LOG)

WHITE OAK

GRADE 1

DATE 11/ 13/ 91

DIAM	LENGTH 8	10	12	14	16
	VOLUMES PER LOG				
6	0	0	0	0	0
7	0	0	0	0	0
8	0	0	0	0	0
9	0	0	0	0	0
10	0	0	0	0	0
11	0	0	0	0	0
12	0	0	0	0	0
13	0	0	0	0	0
14	0	0	0	0	0
15	0	87	108	129	150
16	0	102	126	150	174
17	0	118	145	173	200
18	0	135	166	196	227
19	0	153	187	221	255
20	0	172	210	248	285
21	0	192	234	275	317
22	0	213	259	304	350
23	0	235	285	335	385
24	0	258	312	366	421
25	0	282	340	399	458
26	0	306	370	434	497
27	0	0	0	0	0
28	0	0	0	0	0
29	0	0	0	0	0
30	0	0	0	0	0

201 = AVE. / LOG

SAWDUST LUMBER CO.

CURVED LUMBER YIELD
(VOLUME / MDF-(DOYLE))

WHITE OAK

GRADE 1

DATE 11/ 13/ 91

DIAM	LENGTH 8	10	12	14	16
	VOLUMES PER MBF				
6	0	0	0	0	0
7	0	0	0	0	0
8	0	0	0	0	0
9	0	0	0	0	0
10	0	0	0	0	0
11	0	0	0	0	0
12	0	0	0	0	0
13	0	0	0	0	0
14	0	0	0	0	0
15	0	1269	1254	1244	1237
16	0	1226	1213	1204	1197
17	0	1188	1177	1169	1163
18	0	1155	1146	1138	1133
19	0	1126	1118	1111	1106
20	0	1101	1093	1087	1083
21	0	1077	1070	1065	1061
22	0	1057	1050	1045	1042
23	0	1038	1032	1027	1024
24	0	1021	1015	1011	1008
25	0	1005	1000	996	993
26	0	991	986	982	980
27	0	0	0	0	0
28	0	0	0	0	0
29	0	0	0	0	0
30	0	0	0	0	0

1088 = AVE. / MDF-(DOYLE)

SAWDUST LUMBER CO.

CURVED LUMBER VALUE
(DOLLARS / LOG)

WHITE OAK

GRADE 1

DATE 11/ 13/ 91

DIAM	LENGTH 8	10	12	14	16
	DOLLARS PER LOG				
6	.00	.00	.00	.00	.00
7	.00	.00	.00	.00	.00
8	.00	.00	.00	.00	.00
9	.00	.00	.00	.00	.00
10	.00	.00	.00	.00	.00
11	.00	.00	.00	.00	.00
12	.00	.00	.00	.00	.00
13	.00	.00	.00	.00	.00
14	.00	.00	.00	.00	.00
15	.00	26.42	50.21	74.01	97.80
16	.00	44.63	71.70	98.77	125.84
17	.00	63.89	94.45	125.01	155.57
18	.00	84.21	118.47	152.73	186.99
19	.00	105.59	143.76	181.93	220.11
20	.00	128.02	170.32	212.62	254.92
21	.00	151.52	198.15	244.78	291.41
22	.00	176.07	227.25	278.43	329.61
23	.00	201.67	257.61	313.55	369.49
24	.00	228.34	289.25	350.16	411.06
25	.00	256.06	322.15	388.24	454.33
26	.00	284.84	356.32	427.81	499.29
27	.00	.00	.00	.00	.00
28	.00	.00	.00	.00	.00
29	.00	.00	.00	.00	.00
30	.00	.00	.00	.00	.00

160.21 = AVE. VALUE (DOLLAR) / LOG

SAWDUST LUMBER CO.

CURVED LUMBER VALUE
(DOLLARS / MBF-LMBR TALLY)

WHITE OAK

GRADE 1

DATE 11/ 13/ 91

DIAM	LENGTH 8	10	12	14	16
	DOLLARS PER MBF				
6	.00	.00	.00	.00	.00
7	.00	.00	.00	.00	.00
8	.00	.00	.00	.00	.00
9	.00	.00	.00	.00	.00
10	.00	.00	.00	.00	.00
11	.00	.00	.00	.00	.00
12	.00	.00	.00	.00	.00
13	.00	.00	.00	.00	.00
14	.00	.00	.00	.00	.00
15	.00	545.64	585.71	614.34	635.81
16	.00	605.76	640.99	666.15	685.02
17	.00	657.25	688.46	710.74	727.46
18	.00	701.80	729.63	749.51	764.42
19	.00	740.67	765.65	783.49	796.87
20	.00	774.87	797.41	813.51	825.59
21	.00	805.16	825.61	840.21	851.17
22	.00	832.17	850.80	864.11	874.09
23	.00	856.38	873.43	885.61	894.74
24	.00	878.21	893.87	905.05	913.44
25	.00	897.98	912.41	922.71	930.44
26	.00	915.96	929.30	938.83	945.97
27	.00	.00	.00	.00	.00
28	.00	.00	.00	.00	.00
29	.00	.00	.00	.00	.00
30	.00	.00	.00	.00	.00

796.20 = AVE. (DOLLARS)/MBF-LUMBER TALLY

SAWDUST LUMBER CO.

CHIP VALUES
(DOLLARS PER LOG)

WHITE OAK

GRADE 1

DATE 11/ 13/ 91

DIAM*	LENGTH				
*	8	10	12	14	16
*	-------- DOLLARS PER LOG --------				
6 *	.00	.00	.00	.00	.00
7 *	.00	.00	.00	.00	.00
8 *	.00	.00	.00	.00	.00
9 *	.00	.00	.00	.00	.00
10 *	.00	.00	.00	.00	.00
11 *	.00	.00	.00	.00	.00
12 *	.00	.00	.00	.00	.00
13 *	.00	.00	.00	.00	.00
14 *	.00	.00	.00	.00	.00
15 *	.00	.35	.41	.46	.52
16 *	.00	.39	.45	.51	.58
17 *	.00	.44	.51	.57	.64
18 *	.00	.48	.56	.63	.71
19 *	.00	.53	.61	.70	.79
20 *	.00	.58	.67	.77	.86
21 *	.00	.63	.73	.83	.94
22 *	.00	.68	.80	.91	1.02
23 *	.00	.74	.86	.99	1.12
24 *	.00	.79	.93	1.06	1.20
25 *	.00	.86	1.00	1.15	1.29
26 *	.00	.92	1.08	1.24	1.39
27 *	.00	.00	.00	.00	.00
28 *	.00	.00	.00	.00	.00
29 *	.00	.00	.00	.00	.00
30 *	.00	.00	.00	.00	.00

.55 = AVE. / LOG

SAWDUST LUMBER CO.

PRODUCT VALUE
(DOLLARS / LOG)

WHITE OAK

GRADE 1

DATE 11/ 13/ 91

DIAM*	LENGTH				
*	8	10	12	14	16
*	-------- DOLLARS PER LOG --------				
6 *	.00	.00	.00	.00	.00
7 *	.00	.00	.00	.00	.00
8 *	.00	.00	.00	.00	.00
9 *	.00	.00	.00	.00	.00
10 *	.00	.00	.00	.00	.00
11 *	.00	.00	.00	.00	.00
12 *	.00	.00	.00	.00	.00
13 *	.00	.00	.00	.00	.00
14 *	.00	.00	.00	.00	.00
15 *	.00	26.77	50.62	74.47	98.31
16 *	.00	45.02	72.15	99.28	126.41
17 *	.00	64.33	94.95	125.58	156.21
18 *	.00	84.69	119.03	153.37	187.70
19 *	.00	106.12	144.37	182.63	220.89
20 *	.00	128.60	170.99	213.39	255.78
21 *	.00	152.15	198.88	245.62	292.36
22 *	.00	176.75	228.04	279.34	330.63
23 *	.00	202.41	258.47	314.54	370.60
24 *	.00	229.13	290.18	351.22	412.26
25 *	.00	256.92	323.16	389.39	455.63
26 *	.00	285.76	357.41	429.04	500.68
27 *	.00	.00	.00	.00	.00
28 *	.00	.00	.00	.00	.00
29 *	.00	.00	.00	.00	.00
30 *	.00	.00	.00	.00	.00

160.77 = AVE. VALUE (DOLLAR) / LOG

SAWDUST LUMBER CO.

CHIP VALUES
(DOLLARS PER MDF-LMBR TALLY)

WHITE OAK

GRADE 1

DATE 11/ 13/ 91

DIAM*	LENGTH				
*	8	10	12	14	16
*	-------- DOLLARS PER MBF --------				
6 *	.00	.00	.00	.00	.00
7 *	.00	.00	.00	.00	.00
8 *	.00	.00	.00	.00	.00
9 *	.00	.00	.00	.00	.00
10 *	.00	.00	.00	.00	.00
11 *	.00	.00	.00	.00	.00
12 *	.00	.00	.00	.00	.00
13 *	.00	.00	.00	.00	.00
14 *	.00	.00	.00	.00	.00
15 *	.00	4.05	3.78	3.57	3.42
16 *	.00	3.85	3.60	3.42	3.30
17 *	.00	3.70	3.47	3.33	3.22
18 *	.00	3.55	3.38	3.22	3.13
19 *	.00	3.45	3.27	3.15	3.08
20 *	.00	3.35	3.20	3.10	3.03
21 *	.00	3.27	3.13	3.03	2.98
22 *	.00	3.20	3.08	3.00	2.92
23 *	.00	3.15	3.03	2.95	2.90
24 *	.00	3.08	2.98	2.90	2.85
25 *	.00	3.05	2.95	2.88	2.83
26 *	.00	3.00	2.92	2.85	2.80
27 *	.00	.00	.00	.00	.00
28 *	.00	.00	.00	.00	.00
29 *	.00	.00	.00	.00	.00
30 *	.00	.00	.00	.00	.00

3.23 = AVE. / MDF-(DOYLE)

SAWDUST LUMBER CO.

PRODUCT VALUE
(DOLLARS PER MBF-LMBR TALLY)

WHITE OAK

GRADE 1

DATE 11/ 13/ 91

DIAM*	LENGTH				
*	8	10	12	14	16
*	-------- DOLLARS PER MBF --------				
6 *	.00	.00	.00	.00	.00
7 *	.00	.00	.00	.00	.00
8 *	.00	.00	.00	.00	.00
9 *	.00	.00	.00	.00	.00
10 *	.00	.00	.00	.00	.00
11 *	.00	.00	.00	.00	.00
12 *	.00	.00	.00	.00	.00
13 *	.00	.00	.00	.00	.00
14 *	.00	.00	.00	.00	.00
15 *	.00	549.69	589.49	617.91	639.23
16 *	.00	609.61	644.59	669.57	688.32
17 *	.00	660.95	691.93	714.07	730.68
18 *	.00	705.35	733.00	752.73	767.54
19 *	.00	744.12	768.93	786.64	799.95
20 *	.00	778.22	800.61	816.61	828.62
21 *	.00	808.44	828.73	843.24	854.14
22 *	.00	835.37	853.87	867.11	877.01
23 *	.00	859.53	876.46	888.56	897.64
24 *	.00	871.29	896.84	907.95	916.29
25 *	.00	901.03	915.36	925.59	933.27
26 *	.00	918.96	932.22	941.68	948.77
27 *	.00	.00	.00	.00	.00
28 *	.00	.00	.00	.00	.00
29 *	.00	.00	.00	.00	.00
30 *	.00	.00	.00	.00	.00

687.50 = AVE. / LOG

SAWDUST LUMBER CO

SAWING TIMES
(MINUTES PER LOG)

WHITE OAK

GRADE 1

DATE 11/ 13/ 91

DIAM	LENGTH 8	10	12	14	16
	-------- MINUTES PER LOG --------				
6	.00	.00	.00	.00	.00
7	.00	.00	.00	.00	.00
8	.00	.00	.00	.00	.00
9	.00	.00	.00	.00	.00
10	.00	.00	.00	.00	.00
11	.00	.00	.00	.00	.00
12	.00	.00	.00	.00	.00
13	.00	.00	.00	.00	.00
14	.00	.00	.00	.00	.00
15	.00	2.54	2.70	2.86	3.01
16	.00	2.78	2.96	3.14	3.32
17	.00	3.03	3.24	3.44	3.64
18	.00	3.29	3.52	3.74	3.97
19	.00	3.55	3.81	4.06	4.31
20	.00	3.83	4.10	4.38	4.66
21	.00	4.10	4.41	4.72	5.03
22	.00	4.39	4.73	5.06	5.40
23	.00	4.68	5.05	5.42	5.79
24	.00	4.98	5.38	5.78	6.18
25	.00	5.28	5.72	6.16	6.59
26	.00	5.60	6.07	6.54	7.01
27	.00	.00	.00	.00	.00
28	.00	.00	.00	.00	.00
29	.00	.00	.00	.00	.00
30	.00	.00	.00	.00	.00

4.02 = AVE. / LOG

SAWDUST LUMBER CO.

CONVERSION COST
(DOLLARS PER LOG)

WHITE OAK

GRADE 1

DATE 11/ 13/ 91

DIAM	LENGTH 8	10	12	14	16
	-------- DOLLARS PER LOG --- ----				
6	.00	.00	.00	.00	.00
7	.00	.00	.00	.00	.00
8	.00	.00	.00	.00	.00
9	.00	.00	.00	.00	.00
10	.00	.00	.00	.00	.00
11	.00	.00	.00	.00	.00
12	.00	.00	.00	.00	.00
13	.00	.00	.00	.00	.00
14	.00	.00	.00	.00	.00
15	.00	14.47	15.36	16.26	17.15
16	.00	15.85	16.87	17.88	18.90
17	.00	17.27	18.42	19.57	20.72
18	.00	18.73	20.02	21.31	22.59
19	.00	20.23	21.67	23.10	24.54
20	.00	21.77	23.36	24.95	26.54
21	.00	23.35	25.10	26.86	28.61
22	.00	24.97	26.90	28.82	30.74
23	.00	26.63	28.73	30.83	32.94
24	.00	28.33	30.62	32.91	35.20
25	.00	30.07	32.55	35.04	37.52
26	.00	31.85	34.53	37.22	39.91
27	.00	.00	.00	.00	.00
28	.00	.00	.00	.00	.00
29	.00	.00	.00	.00	.00
30	.00	.00	.00	.00	.00

22.87 = AVE. / LOG

SAWDUST LUMBER CO.

SAWING TIMES
(MINUTES PER MDF-LMBR TALLY)

WHITE OAK

GRADE 1

DATE 11/ 13/ 91

DIAM	LENGTH 8	10	12	14	16
	-------- MINUTES PER MBF --------				
6	.00	.00	.00	.00	.00
7	.00	.00	.00	.00	.00
8	.00	.00	.00	.00	.00
9	.00	.00	.00	.00	.00
10	.00	.00	.00	.00	.00
11	.00	.00	.00	.00	.00
12	.00	.00	.00	.00	.00
13	.00	.00	.00	.00	.00
14	.00	.00	.00	.00	.00
15	.00	25.88	23.23	21.35	19.93
16	.00	24.51	22.19	20.53	19.29
17	.00	23.41	21.36	19.89	18.78
18	.00	22.51	20.68	19.37	18.39
19	.00	21.78	20.13	18.95	18.07
20	.00	21.16	19.68	18.62	17.82
21	.00	20.65	19.31	18.34	17.62
22	.00	20.22	18.99	18.12	17.46
23	.00	19.86	18.74	17.93	17.33
24	.00	19.55	18.52	17.78	17.23
25	.00	19.29	18.34	17.66	17.15
26	.00	19.06	18.18	17.56	17.08
27	.00	.00	.00	.00	.00
28	.00	.00	.00	.00	.00
29	.00	.00	.00	.00	.00
30	.00	.00	.00	.00	.00

19.98 = AVE. / LOG

SAWDUST LUMBER CO.

CONVERSION COST
(DOLLARS PER MBF-LMBR TALLY)

WHITE OAK

GRADE 1

DATE 11/ 13/ 91

DIAM	LENGTH 8	10	12	14	16
	-------- DOLLARS PER MBF --------				
6	.00	.00	.00	.00	.00
7	.00	.00	.00	.00	.00
8	.00	.00	.00	.00	.00
9	.00	.00	.00	.00	.00
10	.00	.00	.00	.00	.00
11	.00	.00	.00	.00	.00
12	.00	.00	.00	.00	.00
13	.00	.00	.00	.00	.00
14	.00	.00	.00	.00	.00
15	.00	147.28	132.24	121.50	113.45
16	.00	139.52	126.30	116.86	109.78
17	.00	133.25	121.55	113.18	106.91
18	.00	128.14	117.70	110.25	104.65
19	.00	123.94	114.57	107.88	102.86
20	.00	120.46	112.00	105.96	101.43
21	.00	117.55	109.88	104.40	100.29
22	.00	115.10	108.11	103.12	99.37
23	.00	113.03	106.64	102.07	98.64
24	.00	111.28	105.40	101.21	98.06
25	.00	109.78	104.36	100.50	97.60
26	.00	108.49	103.49	99.92	97.24
27	.00	.00	.00	.00	.00
28	.00	.00	.00	.00	.00
29	.00	.00	.00	.00	.00
30	.00	.00	.00	.00	.00

113.70 = AVE. / MBF-LMBR TALLY

SAWDUST LUMBER CO.

MAXIMUM LOG VALUE
(DOLLARS PER MBF-(DOYLE)

WHITE OAK

GRADE 1

DATE 11/ 13/ 91

DIAM*	LENGTH				
*	8	10	12	14	16
*	-------- DOLLARS PER MBF --------				
*					
6 *	.00	.00	.00	.00	.00
7 *	.00	.00	.00	.00	.00
8 *	.00	.00	.00	.00	.00
9 *	.00	.00	.00	.00	.00
10 *	.00	.00	.00	.00	.00
11 *	.00	.00	.00	.00	.00
12 *	.00	.00	.00	.00	.00
13 *	.00	.00	.00	.00	.00
14 *	.00	.00	.00	.00	.00
15 *	.00	440.79	499.63	540.77	571.14
16 *	.00	501.46	550.55	584.93	610.35
17 *	.00	548.51	589.98	619.08	640.62
18 *	.00	585.43	620.89	645.76	664.19
19 *	.00	614.77	645.34	666.83	682.78
20 *	.00	638.29	664.90	683.63	697.53
21 *	.00	657.31	680.63	697.06	709.29
22 *	.00	672.79	693.40	707.94	718.72
23 *	.00	685.49	703.79	716.72	726.33
24 *	.00	695.92	712.29	723.85	732.45
25 *	.00	704.58	719.29	729.67	737.40
26 *	.00	711.75	725.04	734.42	741.40
27 *	.00	.00	.00	.00	.00
28 *	.00	.00	.00	.00	.00
29 *	.00	.00	.00	.00	.00
30 *	.00	.00	.00	.00	.00

566.09 = AVE. / MBF-(DOYLE)

SAWDUST LUMBER CO.

'0' PROFIT LOG VALUE
(DOLLARS PER MBF-(DOYLE)

WHITE OAK

GRADE 1

DATE 11/ 13/ 91

DIAM*	LENGTH				
*	8	10	12	14	16
*	-------- DOLLARS PER MBF --------				
*					
6 *	.00	.00	.00	.00	.00
7 *	.00	.00	.00	.00	.00
8 *	.00	.00	.00	.00	.00
9 *	.00	.00	.00	.00	.00
10 *	.00	.00	.00	.00	.00
11 *	.00	.00	.00	.00	.00
12 *	.00	.00	.00	.00	.00
13 *	.00	.00	.00	.00	.00
14 *	.00	.00	.00	.00	.00
15 *	.00	510.53	573.58	617.66	650.19
16 *	.00	576.18	628.75	665.56	692.78
17 *	.00	627.05	671.43	702.57	725.62
18 *	.00	666.93	704.85	731.46	751.17
19 *	.00	698.59	731.27	754 25	771.29
20 *	.00	723.96	752.37	772.38	787.23
21 *	.00	744.41	769.32	786.87	799.92
22 *	.00	761.06	783.05	798.57	810.08
23 *	.00	774.68	794.21	808.00	818.26
24 *	.00	785.86	803.32	815.64	824.81
25 *	.00	795.13	810.80	821.87	830.11
26 *	.00	802.77	816.94	826.93	834.37
27 *	.00	.00	.00	.00	.00
28 *	.00	.00	.00	.00	.00
29 *	.00	.00	.00	.00	.00
30 *	.00	.00	.00	.00	.00

640.48 = AVE. / MBF-(DOYLE)

Statistical information

NUMBER OF LOGS = 22

$/MBF	CONV. $/MBF	TALLY/MBF	
17065.43777	2533.90949	24366.63947	TOTAL
775.70172	115.17770	1107.57452	MEAN
28253.48296	478.28876	5023.34449	VARIANCE
35.83642	4.66266	15.11072	STANDARD ERROR
4.61987	4.04823	1.36431	SE PERCENT OF MEAN

COVARIANCE (1,2).....	-1518.10476
COVARIANCE (1,3).....	1007.32213
COVARIANCE (2,3).....	-579.80638
VARIANCE (Y,X).....	43484.32635
STAND. ERR. (Y,X)..	44.45852
SE PERCENT OF AVE.	6.94149