



1971

U.S. FOREST SERVICE  
RESEARCH NOTE

SO-113

Forest Service, U. S. Dept. of Agriculture

T-10210 FEDERAL BLDG.

701 LOYOLA AVENUE

NEW ORLEANS, LA. 70113

**VOLUME TABLES FOR SMALL COTTONWOODS  
IN PLANTATIONS**C. A. Mohn and R. M. Krinard<sup>1</sup>

SOUTHERN FOREST EXPERIMENT STATION

Tables present total cubic-foot volume inside and outside bark, volume outside bark to a 3½ inch top, and volume inside bark to a 3-inch top for plantation-grown cottonwoods up to 10 inches d.b.h.

Recently, eastern cottonwood (*Populus deltoides* Bartr.) has been planted extensively in the Lower Mississippi Valley, and accurate estimates of volume in small trees are needed to properly manage the plantations. This note presents volume tables for plantation trees up to 10 inches d.b.h. To ascertain volume, one need measure only total height and diameter at breast height.

**SAMPLE TREES**

The tables were developed from measurements of 650 sample trees in three plantations in the Mississippi River Valley near Green-

ville, Mississippi (Latitude 32° N). All trees were 3 or 5 years old. Age and diameter distributions of sample trees are given in table 1.

Table 1.—Age, number, and diameter range of sample trees

| Plantation number | Age   | Trees  | Range of d.b.h. |
|-------------------|-------|--------|-----------------|
|                   | Years | Number | Inches          |
| 1                 | 3     | 233    | 2.4-6.6         |
| 1                 | 5     | 231    | 3.8-8.7         |
| 2                 | 5     | 93     | 4.4-9.9         |
| 3                 | 5     | 93     | 2.3-5.2         |

In all but one instance, sampled trees were selected on a mechanical basis in which both good and poor stems were equally likely to be cut. In Plantation 1 at age 5, selection was slightly biased toward small, poorly formed trees.

The fallen trees were measured, and volumes inside and outside bark were determined by summing volumes for 4-foot stem sections computed by Smalian's formula. In obtaining total tree volumes, the stump was treated as

<sup>1</sup> When the note was written, the authors were Plant Geneticist and Mensurationist at the Southern Hardwoods Laboratory, which is maintained at Stoneville, Mississippi, by the Southern Forest Experiment Station in cooperation with the Mississippi Agricultural and Forestry Experiment Station and the Southern Hardwood Forest Research Group. Mohn is now Assistant Professor, School of Forestry, University of Minnesota.

a cylinder and the tip as a paraboloid. Stump heights were determined from field measurements and averaged approximately 0.5 foot. Bark thickness was measured at 4-foot intervals beginning at stump height.

### VOLUME EQUATIONS

Each of the four tables was constructed from a regression equation:

- (1) Total volume outside bark =  $0.21099 + 0.00221 D^2H$  ( $r^2 = 0.988$ )
- (2) Total volume inside bark =  $-0.06477 + 0.00204 D^2H$  ( $r^2 = 0.979$ )
- (3) Merchantable volume outside bark to a 3½ inch top =  $-0.57780 + 0.00219 D^2H$  ( $r^2 = 0.982$ )
- (4) Merchantable volume inside bark to a 3-inch top =  $-0.62090 + 0.00204 D^2H$  ( $r^2 = 0.973$ )

D is diameter outside the bark at breast height and H is total tree height.

These equations, fitted to the data by least-squares regression, accounted for at least 97 percent of the variation in volume among the

sample trees. Additional variables, such as stem form, bark thickness, and other functions of height and diameter, were examined by stepwise regressions. These accounted for such small proportions of variation in the dependent variables that they were not considered further.

Equation 3 was tested on 60 trees not used in its derivation. These trees had been cut while thinning from below in the Fidler plantations of the St. Francisville Paper Company. The trees were 6 and 7 years old when cut. They ranged from 4.2 to 9.9 inches d.b.h. and from 49 to 82 feet in height. In general, these trees had been far more crowded than those from which the equations were developed. They had been grown in seven different plantings at planting densities up to 1,200 per acre. The volume estimate with equation 3 was 7.7 percent above the measured volume. The relatively accurate result obtained with the regression equation, even when some trees exceeded the limits of the data, suggests that the tables may be suitable for a broad range of plantation conditions.

Table 2.—Total cubic-foot volumes<sup>1</sup> outside bark for cottonwood in plantations<sup>2</sup>

| D.b.h.<br>(inches) | Total tree height (feet) |      |      |      |      |      |       |       |       |       | No. trees<br>measured |     |
|--------------------|--------------------------|------|------|------|------|------|-------|-------|-------|-------|-----------------------|-----|
|                    | 25                       | 30   | 35   | 40   | 45   | 50   | 55    | 60    | 65    | 70    |                       |     |
| 2.5                | 0.56                     | 0.63 | 0.69 |      |      |      |       |       |       |       |                       | 14  |
| 3.0                | .71                      | .81  | .91  | 1.01 |      |      |       |       |       |       |                       | 16  |
| 3.5                | .89                      | 1.02 | 1.16 | 1.29 | 1.43 |      |       |       |       |       |                       | 40  |
| 4.0                | 1.10                     | 1.27 | 1.45 | 1.63 | 1.80 | 1.98 |       |       |       |       |                       | 86  |
| 4.5                | 1.33                     | 1.55 | 1.78 | 2.00 | 2.22 | 2.45 | 2.67  |       |       |       |                       | 104 |
| 5.0                |                          | 1.86 | 2.14 | 2.42 | 2.70 | 2.97 | 3.25  | 3.53  |       |       |                       | 82  |
| 5.5                |                          | 2.22 | 2.55 | 2.89 | 3.22 | 3.55 | 3.89  | 4.22  |       |       |                       | 42  |
| 6.0                |                          |      | 3.00 | 3.39 | 3.79 | 4.19 | 4.59  | 4.98  | 5.38  |       |                       | 59  |
| 6.5                |                          |      |      | 3.95 | 4.41 | 4.88 | 5.35  | 5.81  | 6.28  |       |                       | 58  |
| 7.0                |                          |      |      |      | 5.08 | 5.63 | 6.17  | 6.71  | 7.25  | 7.79  |                       | 61  |
| 7.5                |                          |      |      |      | 5.80 | 6.43 | 7.05  | 7.67  | 8.29  | 8.91  |                       | 46  |
| 8.0                |                          |      |      |      |      | 7.28 | 7.99  | 8.70  | 9.40  | 10.11 |                       | 20  |
| 8.5                |                          |      |      |      |      | 8.19 | 8.99  | 9.79  | 10.59 | 11.39 |                       | 12  |
| 9.0                |                          |      |      |      |      |      | 10.06 | 10.95 | 11.85 | 12.74 |                       | 5   |
| 9.5                |                          |      |      |      |      |      |       | 12.18 | 13.18 | 14.17 |                       | 4   |
| 10.0               |                          |      |      |      |      |      |       |       | 13.47 | 14.58 | 15.68                 | 1   |

<sup>1</sup> Includes wood and bark of entire stem from ground to tip.

<sup>2</sup> Standard error of estimate = 0.283.

Table 3.—Total cubic-foot volumes<sup>1</sup> inside bark for cottonwood in plantations<sup>2</sup>

| D.b.h.<br>(inches) | Total tree height (feet) |      |      |      |      |      |      |       |       |       |
|--------------------|--------------------------|------|------|------|------|------|------|-------|-------|-------|
|                    | 25                       | 30   | 35   | 40   | 45   | 50   | 55   | 60    | 65    | 70    |
| 2.5                | 0.25                     | 0.32 | 0.38 |      |      |      |      |       |       |       |
| 3.0                | .39                      | .49  | .58  | 0.67 |      |      |      |       |       |       |
| 3.5                | .56                      | .68  | .81  | .93  | 1.06 |      |      |       |       |       |
| 4.0                | .75                      | .91  | 1.08 | 1.24 | 1.40 | 1.57 |      |       |       |       |
| 4.5                | .97                      | 1.17 | 1.38 | 1.59 | 1.79 | 2.00 | 2.21 |       |       |       |
| 5.0                |                          | 1.47 | 1.72 | 1.98 | 2.23 | 2.49 | 2.74 | 3.00  |       |       |
| 5.5                |                          | 1.73 | 2.10 | 2.40 | 2.71 | 3.02 | 3.33 | 3.64  |       |       |
| 6.0                |                          |      | 2.51 | 2.87 | 3.24 | 3.61 | 3.97 | 4.34  | 4.71  |       |
| 6.5                |                          |      |      | 3.38 | 3.81 | 4.24 | 4.68 | 5.11  | 5.54  |       |
| 7.0                |                          |      |      |      | 4.43 | 4.93 | 5.43 | 5.93  | 6.43  | 6.93  |
| 7.5                |                          |      |      |      | 5.10 | 5.67 | 6.25 | 6.82  | 7.39  | 7.97  |
| 8.0                |                          |      |      |      |      | 6.46 | 7.12 | 7.77  | 8.42  | 9.07  |
| 8.5                |                          |      |      |      |      | 7.30 | 8.04 | 8.78  | 9.52  | 10.25 |
| 9.0                |                          |      |      |      |      |      | 9.02 | 8.85  | 10.68 | 11.50 |
| 9.5                |                          |      |      |      |      |      |      | 10.98 | 11.90 | 12.82 |
| 10.0               |                          |      |      |      |      |      |      | 12.18 | 13.20 | 14.22 |

<sup>1</sup> Includes wood of entire stem from ground to tip.

<sup>2</sup> Standard error of estimate = 0.353.

Table 4.—Cubic-foot volumes<sup>1</sup> outside bark to 3½ inch top for cottonwood in plantations<sup>2</sup>

| D.b.h.<br>(inches) | Total tree height (feet) |      |      |      |      |      |      |       |       |       |
|--------------------|--------------------------|------|------|------|------|------|------|-------|-------|-------|
|                    | 25                       | 30   | 35   | 40   | 45   | 50   | 55   | 60    | 65    | 70    |
| 4.0                | 0.30                     | 0.47 | 0.65 | 0.82 | 1.00 | 1.17 |      |       |       |       |
| 4.5                | .53                      | .75  | .97  | 1.20 | 1.42 | 1.64 | 1.86 |       |       |       |
| 5.0                |                          | 1.06 | 1.34 | 1.61 | 1.89 | 2.16 | 2.43 | 2.71  |       |       |
| 5.5                |                          | 1.41 | 1.74 | 2.07 | 2.40 | 2.73 | 3.07 | 3.40  |       |       |
| 6.0                |                          |      | 2.18 | 2.58 | 2.97 | 3.36 | 3.76 | 4.15  | 4.55  |       |
| 6.5                |                          |      |      | 3.12 | 3.59 | 4.05 | 4.51 | 4.97  | 5.44  |       |
| 7.0                |                          |      |      |      | 4.25 | 4.79 | 5.32 | 5.86  | 6.40  | 6.93  |
| 7.5                |                          |      |      |      | 4.97 | 5.58 | 6.20 | 6.81  | 7.43  | 7.97  |
| 8.0                |                          |      |      |      |      | 6.43 | 7.13 | 7.83  | 8.53  | 9.07  |
| 8.5                |                          |      |      |      |      | 7.33 | 8.12 | 8.92  | 9.71  | 10.25 |
| 9.0                |                          |      |      |      |      |      | 9.18 | 10.07 | 10.95 | 11.50 |
| 9.5                |                          |      |      |      |      |      |      | 11.28 | 12.27 | 12.82 |
| 10.0               |                          |      |      |      |      |      |      | 12.56 | 13.66 | 14.22 |

<sup>1</sup> Volume excludes stump 0.5 foot in height.

<sup>2</sup> Standard error of estimate = 0.349.

Table 5.—Cubic-foot volumes<sup>1</sup> inside bark to 3-inch top for cottonwood in plantations<sup>2</sup>

| D.b.h.<br>(inches) | Total tree height (feet) |      |      |      |      |      |      |       |       |       |
|--------------------|--------------------------|------|------|------|------|------|------|-------|-------|-------|
|                    | 25                       | 30   | 35   | 40   | 45   | 50   | 55   | 60    | 65    | 70    |
| 4.0                | 0.20                     | 0.36 | 0.52 | 0.68 | 0.85 | 1.01 |      |       |       |       |
| 4.5                | .41                      | .62  | .82  | 1.03 | 1.24 | 1.44 | 1.66 |       |       |       |
| 5.0                |                          | .91  | 1.16 | 1.42 | 1.67 | 1.93 | 2.18 | 2.44  |       |       |
| 5.5                |                          | 1.23 | 1.54 | 1.85 | 2.16 | 2.46 | 2.77 | 3.08  |       |       |
| 6.0                |                          |      | 1.95 | 2.32 | 2.68 | 3.05 | 3.42 | 3.79  | 4.15  |       |
| 6.5                |                          |      |      | 2.83 | 3.26 | 3.69 | 4.12 | 4.55  | 4.98  |       |
| 7.0                |                          |      |      |      | 3.89 | 4.38 | 4.88 | 5.38  | 5.88  | 6.38  |
| 7.5                |                          |      |      |      | 4.54 | 5.12 | 5.69 | 6.26  | 6.84  | 7.41  |
| 8.0                |                          |      |      |      |      | 5.91 | 6.56 | 7.21  | 7.87  | 8.52  |
| 8.5                |                          |      |      |      |      | 6.75 | 7.49 | 8.22  | 8.96  | 9.70  |
| 9.0                |                          |      |      |      |      |      | 8.47 | 9.29  | 10.12 | 10.95 |
| 9.5                |                          |      |      |      |      |      |      | 10.43 | 11.35 | 12.27 |
| 10.0               |                          |      |      |      |      |      |      | 11.62 | 12.64 | 13.66 |

<sup>1</sup> Volume excludes stump 0.5 foot in height.

<sup>2</sup> Standard error of estimate = 0.400.