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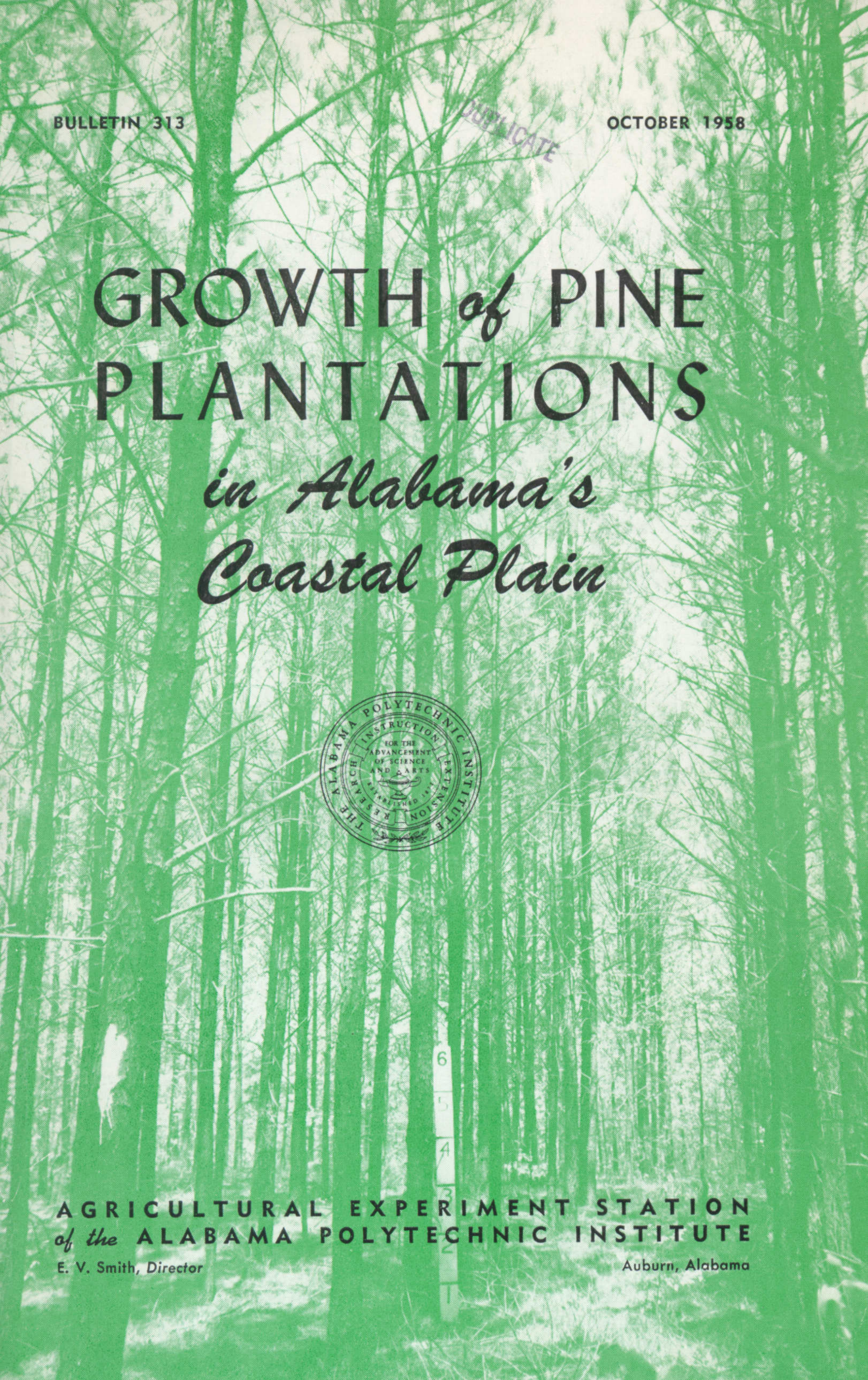
GROWTH *of* PINE PLANTATIONS *in Alabama's Coastal Plain*



AGRICULTURAL EXPERIMENT STATION
of the ALABAMA POLYTECHNIC INSTITUTE

E. V. Smith, *Director* Auburn, Alabama

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The **COVER** . . . This 15-year-old loblolly pine plantation is growing on soil of the Akron series. Topsoil on the site is 16 inches deep and has an average silt plus clay content of 40.6 per cent. There are 800 trees per acre. Actual average height of tallest trees is 42.6 feet and actual merchantable volume is 20.2 cords of rough wood per acre. Using the formulas given in the bulletin, estimated height of tallest trees is 41.0 feet. Using this height, estimated merchantable volume is 19.7 cords of rough wood per acre.

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GROWTH *of* PINE PLANTATIONS
in Alabama's Coastal Plain

JAMES F. GOGGANS, *Associate Forester*
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VAST ACREAGES of pine trees were planted in Alabama from 1935 to 1942 by the Civilian Conservation Corps, WPA, and other organizations using relief labor. After World War II, individual landowners continued planting trees, and this practice has grown rapidly. At present, planting trees is an important method of reproducing forests and of converting old fields to forests.

The Agricultural Experiment Station of the Alabama Polytechnic Institute has recently completed a study of slash, loblolly, and longleaf pine plantations in the State's Coastal Plain. One of the main objectives of the study was to gain knowledge that would be useful in the present tree-planting programs within the State. Particular attention was given to the effects of various soil characteristics on growth of young trees.

This Bulletin reports a study of the correlation of soils and other site factors with the height growth of 5- to 16-year-old slash, loblolly, and longleaf pine. Equations for estimating height growth and merchantable volume growth of the three species are given.

STUDY AREA

Figure 1 shows that part of the Alabama Coastal Plain covered by this investigation.

Loblolly pine, *Pinus taeda* L., and longleaf pine, *Pinus palustris* Mill., are native to the Alabama Coastal Plain. Slash pine, *Pinus*

[1] Resigned.

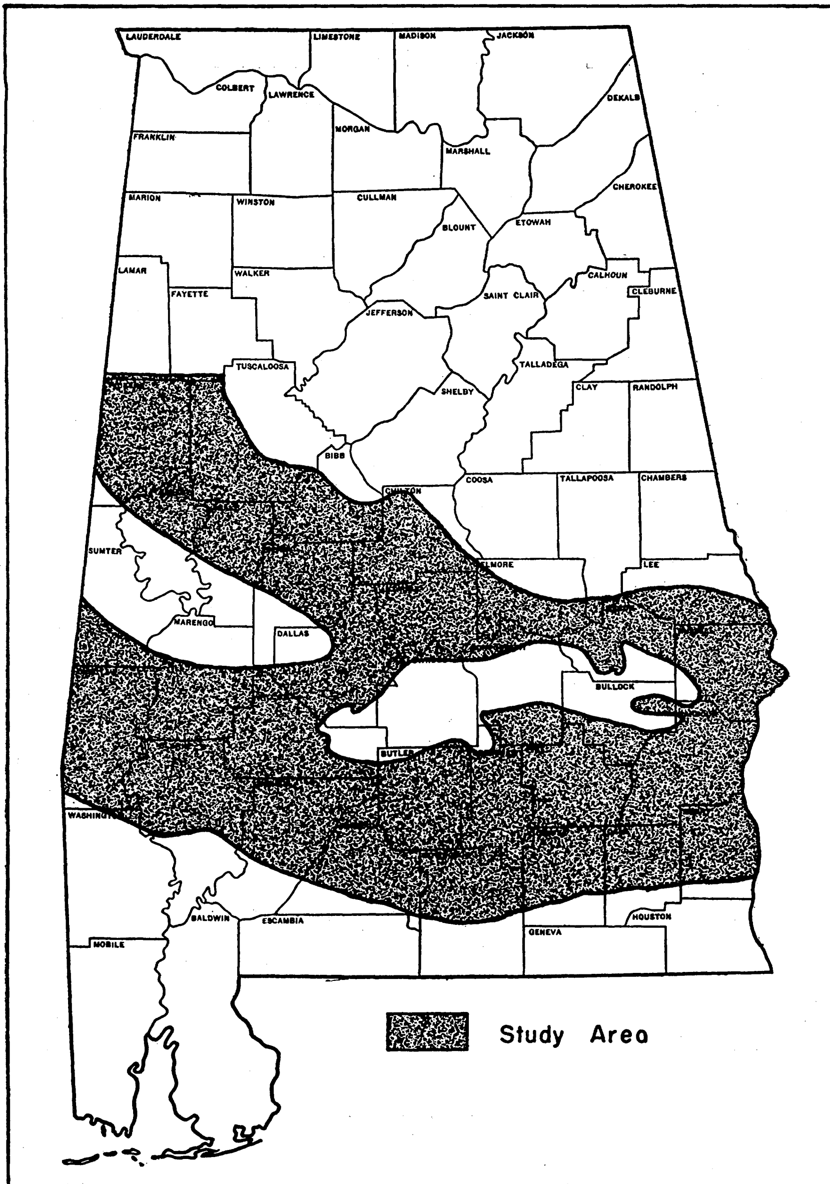

FIGURE 1. Shaded area on map is that part of the Coastal Plain Region of Alabama where study was conducted.

elliottii Engelm., is not native to the sites studied. Originally slash pine occurred only in the lowlands and moist areas of the southernmost counties of the State. During the period of emergency labor (CCC, WPA), slash pine was planted on upland sites and at northern localities of Alabama's Coastal Plain and Piedmont regions.

The study area is characterized by an average annual rainfall of approximately 50 to 58 inches *(14)*. Rain is usually plentiful during winter and spring. Rainfall during May and June is less, and local drought conditions are likely to prevail. July is usually a month of plentiful rain, which revives crops suffering from the preceding drought and sustains those in good growing condition. After July, rainfall gradually decreases until a low is reached in the fall, which is the driest season of the year. Average warm season precipitation (April through September) varies from 22 to 28 inches. The average date of the last killing frost varies from March 15 in the southern part to March 25 in the northern portion of the area. Average growing season is 220 to 250 days.

Topography of the study area is rolling to quite hilly. Surface drainage is good and there are numerous streams. Most of the area has been farmed or pastured at one time; therefore, both sheet and gully erosion have occurred, especially in the more hilly areas.

The most important soils of the study area are those associated with the Norfolk-Ruston and Susquehanna-Savannah-Ruston soil areas as described in Soils and Men *(15)*. Those non-study areas that occur within the study area are Black Belt or black prairie soils.

PAST WORK

Interest in forest soils, particularly in soil factors related to tree growth, has been high during the past 15 years. In the South numerous studies that have related soils and site factors to height growth of southern pines have been made.

Gaines *(8)* and Coile *(6,7)* are among those who have reviewed the literature in this field. Since these reviews were made, Barnes and Ralston *(1)*, McClurkin *(10)*, Zahner *(17)*, and Goggans *(9)* have reported additional studies of the growth of southern pine. Most of the studies reported have been concerned with trees that were over 30 years old. Very little work of this nature has been done with young trees. Barnes and Ralston *(1)* and Goggans *(9)* have reported on young plantation growth. Beaufait *(2)* has reported on a study of the influence of soil and topography on willow oak sites. Most of these studies bring out the importance of soil physical characteristics, particularly topsoil characteristics, in determining height growth of trees. Most of these studies have not considered the effect of nutrient element concentration on tree growth. It is well known that soil physical characteristics and availability of water can overshadow the effects of mineral nutrients. Yet, nutrients are required for tree growth and they may be limiting.

Coile *(6)* summed up the situation regarding soil-site studies when he said, "Site quality is largely determined by soil properties, or other features of site, which influence the quality and quantity of growing space for roots. Success or failure in demonstrating significant relationships between soil properties and plant growth depends largely on the investigator's ability to select for measurement and statistical tests the independent variables that are initially limiting or most limiting."

METHODS *of* INVESTIGATION

Field Procedures

Old field plantings of 5- to 16-year-old slash, loblolly, and longleaf pine were examined. One-tenth-acre square study plots were used. Plot locations in plantings with at least 200 trees per acre were selected in such a way as to be representative of the well-drained, upland sites found in the area. No plots were located in bottoms. Most plots were on soils of the Norfolk, Gilead, Guin, Ruston, Orangeburg, Akron, Shubuta, Boswell, Luverne, and Greenville series. A few plots were on soils of the Kirven, Magnolia, Faceville, and Red Bay series. Table 1 presents general information concerning the plots used in this study.

An extensive description of each plot was recorded. History of the land before and after planting was investigated. Physical

TABLE 1. GENERAL INFORMATION CONCERNING PLOTS STUDIED

Species	Number of plots	Average survival	Trees per plot	Average age
		Per cent	*Av. no.*	*Year*
Slash pine	69	54	64	10.7
Loblolly pine	46	70	82	10.3
Longleaf pine	40	39	42	10.9

site factors were recorded. Soil wells were dug inside each of the four plot corners. The soil profile was described in detail. Composite samples of each soil horizon were collected from the four wells.

It was evident from histories that the old fields on which the plantations were established had received a range of fertilizer treatments. While some of the old fields had received no fertilizer, others had been fertilized for row crops for many years. It was believed that the mineral nutrient element concentrations in the old fields varied widely and that, because of this wide variation, some of the nutrient element concentrations might be correlated with height growth. To provide a sample for nutrient element analyses, a composite sample of the upper 6 inches of the soil profile was collected from 10 systematically selected spots that were evenly distributed over the plot.

The diameter at breast height of each tree was measured and the height of each tree was estimated ocularly to the nearest 5 feet. Volume of rough wood in cords was calculated using Tables 3, 11, and 27 of USDA Miscellaneous Publication No. 50 *(16)*. Heights of 10 of the tallest trees were measured with a measuring pole and the average of these 10 measurements was used as the height figure for the plot. This height figure was used as a criterion of site quality.

Laboratory Procedures

In the soils laboratory, the percentages of sand, silt, and clay were determined for all soil samples by the Bouyoucos hydrometer method *(3)*.

If the A horizon had two or more subdivisions (A_1, A_2, A_3, etc.), a weighted average of the silt plus clay content of the entire A horizon was calculated. For example, if a soil had A_1, A_2, and A_3 horizons, the thickness in inches of each subdivision was multiplied by its percentage of silt plus clay. The products for all subdivisions were added and the sum divided by the total thickness of the entire A horizon to give a weighted average.

Imbibitional water value, which is the difference between moisture equivalent *(5)* and xylene equivalent, was determined for subsoil samples.

Tests for organic matter, potassium supplying power, and nutrient element concentration were performed on samples of the upper 6-inch layer. Percentage of soil organic matter was determined by the wet combustion method described by Peech et al. *(11)*. Potassium for the potassium-supplying power test was extracted by boiling in nitric acid *(12)*. The amount of potassium in the extract was measured by the flame photometry method, using a Beckman DU Spectrophotometer. Phosphorus was extracted with 0.1N HCL and NH_4F, and the amount of phosphorus in the extract was determined colormetrically *(4)*. Exchangeable calcium, magnesium, and potassium were extracted with 1N ammonium acetate and their extract concentrations measured by the flame photometry method using a Beckman DU Spectrophotometer.

Statistical Procedures

Multiple regression techniques as described by Schultz and Goggans *(13)* were used with some modification to select the best independent variables for estimating both height and merchantable volume. The most potent first variable is that single independent variable most closely correlated with the dependent variable. The most potent second variable is the one that, when used with the most potent first variable, yields the pair of independent variables most closely correlated with the dependent variable. The most potent third variable is the independent variable that, when used with the most potent pair, yields the trio of independent variables most closely correlated with the dependent variable. This process can be extended.

In the search for factors correlated with height of pines in plantations, the following general procedure was followed. All factors to be considered were divided into three groups: (1) age and soil physical factors, (2) soil chemical factors, and (3) climatic and stand-density factors. For each species, the group of age and soil physical factors was examined by the method cited, using height as the dependent variable. The most potent variables from the first group were added to the list of soil chemical factors and the process was repeated for each species. The most potent variables from this search were added to the climatic and stand-density factors, and the process was again repeated.

All variables that showed promise as predictors at any time in any of the foregoing three series for any species were grouped to create a final list of factors, which were again examined for all three species by the process described.

VARIABLES CORRELATED *with* HEIGHT

The group of age and soil physical factors examined for relationship with height of tallest trees were:

Age (years since plantation establishment)

Depth of topsoil (inches)

$(\text{Age})^2$

$(\text{Depth of topsoil})^2$

Age × depth of topsoil

Silt plus clay content of topsoil (per cent, weighted average for entire A horizon)

Depth of topsoil × silt plus clay content of topsoil

Age × silt plus clay content of topsoil

Silt plus clay content of the B_1 horizon

Imbibitional water value of the most impervious horizon

Silt plus clay content of the B_1 horizon × I.W.V. of the most impervious horizon

In the second group of regressions, the most potent variables of the above group and soil chemical factors were used as independent variables. The soil chemical factors were as follows:

Calcium (m.e./100 gm.)

Phosphorus (p.p.m.)

Calcium plus magnesium plus potassium (m.e./100 gm.)

Potassium (m.e./100 gm.)

Potassium supplying power (m.e./100 gm.)

Organic matter (per cent)

Calcium/potassium

Calcium plus magnesium/potassium

In the third group of regressions, the most potent variables of the second group were added to the climatic and stand density factors and used as independent variables. The climatic and stand density factors were as follows:

Average warm season (April through September) precipitation (inches)

Average annual precipitation (inches)

Average number of frost free days per year

Number of trees per acre

(Number of trees)^2
Number of trees × age
Number of trees × depth of topsoil
Number of trees × silt plus clay content of the topsoil

From these three series, a final list of factors was developed. All variables that showed promise as predictors at any time for any species were included. These variables were:

Age
Age × depth of topsoil
(Age)^2
(Depth of topsoil)^2
Percentage of organic matter
Average warm season precipitation
Average annual precipitation
Age × number of trees
Number of trees × depth of topsoil
Number of trees × silt plus clay content of topsoil
Depth of topsoil × silt plus clay content of topsoil
Age × silt plus clay content of topsoil
Silt plus clay content of B_1 horizon
I.W.V. of most impervious horizon
Silt plus clay content of B_1 horizon × I.W.V. of most impervious horizon
Phosphorus
Potassium
Potassium supplying power
Calcium plus magnesium/potassium

The most potent variables in this group were selected for each species by the process previously described.

For slash pine the selected variables, in order of their potency (X_1 most potent first, X_2 most potent second, etc.), were: X_1 = age, X_2 = depth of topsoil × silt plus clay content of topsoil, X_3 = age × silt plus clay content of topsoil, X_4 = silt plus clay content of B_1 horizon, and X_5 = average warm season precipitation. For loblolly pine the variables in order of their potency were: X_1 = age, X_2 = age × depth of topsoil, X_3 = (age)^2, X_4 = (depth of topsoil)^2 and X_5 = organic matter. For longleaf pine the variables in the order of their potency were: X_1 = age, X_2 = I.W.V. of most impervious horizon, X_3 = organic matter. Not all of these variables were actually significant at the 5 per cent level or higher.

In the longleaf pine regressions, none of the independent variables except age was significant. With this species, age alone is practically as good an estimator of height of dominant trees in 8- to 16-year-old plantations as are combinations of age and other variables.

Examination of results leading to selection of the most potent predictors of height for slash and loblolly pine gave an indication that the same independent variables might be used for estimating heights of both species.

Age was the most potent first variable for each species.

For slash pine, depth of topsoil × silt plus clay content of topsoil was the most potent second variable.

For loblolly pine, age × depth of topsoil was the most potent second variable (total reduction of sum of squares due to age and this variable = 3184); however, depth of topsoil × silt plus clay content of topsoil was nearly as potent as a second variable (total reduction due to age and this variable = 3167). With either of these as the second variable, the most potent third variable was $(\text{age})^2$. In combination with age and $(\text{age})^2$, depth of topsoil × silt plus clay content of topsoil yielded a slightly more potent three variable regression than did age × depth of topsoil.

The results for slash pine show that with age and depth of topsoil × silt plus clay content of topsoil as the first two variables, the most potent third variable was age × silt plus clay content of topsoil (total reduction because of these three variables = 6534). $(\text{Age})^2$ was nearly as good as a third variable, and reduced the variability significantly with the total reduction because of these three variables = 6511.

Thus, it would seem permissible to use age, depth of topsoil × silt plus clay content of topsoil, and $(\text{age})^2$ as predictor variables for both species.

The final equation adopted for slash pine was:

$$\text{Height of tallest trees} = -11.94 + 5.11(\text{Age}) + 0.00929(\text{Depth of topsoil} \times \text{silt plus clay content of topsoil}) - 0.1127(\text{Age}^2)$$

Table 2 shows heights estimated with this equation.

TABLE 2. ESTIMATED HEIGHTS OF TALLEST TREES IN SLASH PINE PLANTATIONS

Depth of topsoil	Silt plus clay content of topsoil	Age (years)												
		5	6	7	8	9	10	10.67 (Av.)	11	12	13	14	15	16
								Feet						
Shallow (6 inches)	Low (10%)	11.3	15.2[1]	18.9	22.3	25.5	28.4	30.3	31.2	33.7	36.0	38.1	39.9	41.5
	Average (20%)	11.9	15.8	19.4	22.8	26.0	29.0	30.9	31.7	34.3	36.6	38.6	40.5	42.1
	High (35%)	12.7	16.6	20.2	23.7	26.9	29.8	31.7	32.6	35.1	37.4	39.5	41.3	42.9
Average (22 inches)	Low (10%)	12.8	16.7	20.4	23.8	27.0	29.9	31.8	32.7	35.2	37.5	39.6	41.4	43.0
	Average (20%)	14.9	18.8	22.4	25.8	29.0	32.0	33.8[2]	34.7	37.2	39.5	41.6	43.4	45.0
	High (35%)	17.9	21.8	25.5	28.9	32.1	35.0	36.9	37.8	40.3	42.6	44.7	46.5	48.1
Deep (50 inches)	Low (10%)	15.4	19.3	23.0	26.4	29.6	32.5	34.4	35.3	37.8	40.1	42.2	44.0	45.6
	Average (20%)	20.1	24.0	27.6	31.0	34.2	37.2	39.0	39.9	42.4	44.7	46.8	48.6	50.2
	High (35%)	27.0	30.9	34.6	38.0	41.2	44.1	46.0	46.9	49.4	51.7	53.8	55.6[3]	57.2

[1] Five per cent confidence limits at this point are ± 2.0 feet.
[2] Five per cent confidence limits at this point are ± 0.9 feet.
[3] Five per cent confidence limits at this point are ± 5.5 feet.

TABLE 3. ESTIMATED HEIGHTS OF TALLEST TREES IN LOBLOLLY PINE PLANTATIONS

Depth of topsoil	Silt plus clay content of topsoil	Age (years)												
		5	6	7	8	9	10	10.33 (Av.)	11	12	13	14	15	16
								Feet						
	Low (10%)	11.1	15.1[1]	18.8	22.2	25.2	27.9	28.7	30.3	32.3	33.9	35.2	36.2	36.8
Shallow	Average (20%)	11.6	15.6	19.3	22.7	25.7	28.4	29.2	30.8	32.8	34.4	35.7	36.6	37.3
(6 inches)	High (35%)	12.3	16.4	20.1	23.4	26.5	29.2	30.0	31.5	33.5	35.1	36.4	37.4	38.0
	Low (10%)	12.0	16.1	19.8	23.2	26.2	28.9	29.7	31.2	33.2	34.9	36.2	37.1	37.8
Average	Average (20%)	13.5	17.6	21.3	24.7	27.7	30.4	31.2[2]	32.7	34.7	36.4	37.7	38.6	39.2
(18 inches)	High (35%)	15.7	19.8	23.5	26.9	29.9	32.6	33.4	34.9	36.9	38.6	39.9	40.8	41.4
	Low (10%)	14.7	18.7	22.4	25.8	28.8	31.5	32.3	33.9	35.9	37.5	38.8	39.8	40.4
Deep	Average (20%)	18.8	22.8	26.5	29.9	32.9	35.6	36.4	38.0	40.0	41.6	42.9	43.8	44.5
(50 inches)	High (35%)	24.9	29.0	32.7	36.0	39.1	41.8	42.6	44.1	46.1	47.7	49.0	50.0[3]	50.6

[1] Five per cent confidence limits at this point are ± 3.1 feet.
[2] Five per cent confidence limits at this point are ± 1.4 feet.
[3] Five per cent confidence limits at this point are ± 9.8 feet.

The final equation adopted for loblolly pine was:

Height of tallest trees = –14.91 + 5.96(Age) + 0.00818(Depth of topsoil × silt plus clay content of topsoil) – 0.1725(Age^2)

Table 3 shows heights estimated with this equation.

The above equations should not be used for ages below 5 years or above 16 years.

Height of longleaf pine can be estimated from age alone:

Height of tallest trees = 2.44 + 2.385(Age)

This equation should not be used for ages below 8 years or above 16 years. Heights of tallest trees in longleaf pine plantations estimated with this equation are as follows:

AGE *Years*	HEIGHT *Feet*
8	21.5[2]
9	23.9
10	26.3
10.9 (average)	28.4[3]
11	28.7
12	31.1
13	33.4
14	35.8
15	38.2[4]
16	40.6

VARIABLES CORRELATED *with* MERCHANTABLE VOLUME

In an attempt to make it possible to use the estimated height of tallest trees to estimate the early merchantable volume production of old field plantations, the following portion of the study was made.

Using the previously described regression techniques, independent variables for estimating the merchantable volume of 9- to 16-year-old slash, loblolly, and longleaf pine plantations were chosen. These independent variables were chosen from the following group:

Age (years since plantation establishment)

$(Age)^2$

Number of trees (per acre)

$(Number\ of\ trees)^2$

Age × number of trees

[2] Five per cent confidence limits at this point are ± 2.43 feet.
[3] Five per cent confidence limits at this point are ± 1.48 feet.
[4] Five per cent confidence limits at this point are ± 3.02 feet.

Height (of tallest trees in feet)
(Height)^2
(Height)^3
Height $\times$ age
Height $\times$ number of trees

$$\frac{(\text{Number of trees})^2(\text{age})}{\text{Height}}$$

$$\frac{\text{Number of trees} \times \text{height}}{\text{Age}}$$

The variables chosen for all three species were height of tallest trees and number of trees per acre. While these variables were not the most potent set in all cases, they allowed an estimate of merchantable volume that was practically as good as any set of variables from the above group.

The equation adopted for the estimation of merchantable volume in cords of rough wood per acre for slash pine was:

Merchantable volume = –30.48 + 1.0196(Height of tallest trees in feet) + 0.013213(Number of trees per acre)

The equation adopted for loblolly pine was:

Merchantable volume = –22.06 + 0.9661(Height of tallest trees in feet) + 0.002724(Number of trees per acre)

The equation adopted for longleaf pine was:

Merchantable volume = –20.45 + 0.7756(Height of tallest trees in feet) + 0.006304(Number of trees per acre)

Tables 4, 5, and 6 show volumes estimated with the foregoing equations. After average height of the tallest trees is estimated from the soil factors and for any given age, height in turn can be used in these equations to estimate merchantable volume production. Of course, the estimates of height have confidence limits. The range of these limits is shown by footnotes of Tables 2 and 3, and on page 14. Ages from 8 to 13 years and soil variable values near the average will produce the most accurate height estimates.

Estimates of merchantable volume have confidence limits also. Assuming that height figures used in the volume equations are measured values, the confidence limits are as shown in footnotes of Tables 4, 5, and 6. As with the equations for estimating height,

TABLE 4. ESTIMATED MERCHANTABLE VOLUME PER ACRE OF 9- TO 16-YEAR-OLD SLASH PINE PLANTATIONS

Number of trees per acre	Height of tallest trees (feet)					
	25	30	35[1]	40	45	50
	Cords	*Cords*	*Cords*	*Cords*	*Cords*	*Cords*
400	0.30[2]	5.39	10.49	15.59	20.69	25.78
500	1.62	6.71	11.81	16.91	22.01	27.11
600[3]	2.94	8.04	13.13[4]	18.23	23.33	28.43
700	4.26	9.36	14.46	19.55	24.65	29.75
800	5.58	10.68	15.78	20.87	25.97	31.07
900	6.90	12.00	17.10	22.20	27.29	32.39
1,000	8.22	13.32	18.42	23.52	28.62[5]	33.71

[1] Average height was 37.2 feet.
[2] Five per cent confidence limits at this point are ± 1.49
[3] Average number of trees per acre was 590.
[4] Five per cent confidence limits at this point are ± 0.64
[5] Five per cent confidence limits at this point are ± 1.61

TABLE 5. ESTIMATED MERCHANTABLE VOLUME PER ACRE OF 9- TO 16-YEAR-OLD LOBLOLLY PINE PLANTATIONS

Number of trees per acre	Height of tallest trees (feet)					
	25	30	35[1]	40	45	50
	Cords	*Cords*	*Cords*	*Cords*	*Cords*	*Cords*
400	3.18[2]	8.01	12.84	17.67	22.50	27.33
500	3.45	8.28	13.12	17.95	22.78	27.61
600	3.73	8.56	13.39	18.22	23.05	27.88
700	4.00	8.83	13.66	18.49	23.32	28.15
800[3]	4.27	9.10	13.93[4]	18.76	23.59	28.42
900	4.54	9.37	14.20	19.04	23.87	28.70
1,000	4.82	9.65	14.48	19.31	24.14[5]	28.97

[1] Average height was 34.0 feet.
[2] Five per cent confidence limits at this point are ± 1.78
[3] Average number of trees per acre was 765.
[4] Five per cent confidence limits at this point are ± 0.76
[5] Five per cent confidence limits at this point are ± 1.73

TABLE 6. ESTIMATED MERCHANTABLE VOLUME PER ACRE OF 9- TO 16-YEAR-OLD LONGLEAF PINE PLANTATIONS

Number of trees per acre	Height of tallest trees (feet)				
	25	30[1]	35	40	45
	Cords	*Cords*	*Cords*	*Cords*	*Cords*
400[2]	1.46[3]	5.34[4]	9.22	13.10	16.97
500	2.09	5.97	9.85	13.73	17.60
600	2.72	6.60	10.48	14.36	18.23
700	3.35	7.23	11.11	14.99	18.86
800	3.98	7.86	11.74	15.62	19.50
900	4.61	8.49	12.37	16.25	20.12
1,000	5.24	9.12	13.00	16.88	20.76[5]

[1] Average height was 31.1 feet.
[2] Average number of trees per acre was 412.
[3] Five per cent confidence limits at this point are ± 1.05
[4] Five per cent confidence limits at this point are ± 0.64
[5] Five per cent confidence limits at this point are ± 2.49

the most accurate volume estimations will come from using independent variable values that are close to the average value of the variable. The volume equations should not be used for values of the independent variables beyond the ranges used in Tables 4, 5, and 6.

SUMMARY

The Agricultural Experiment Station has completed a study of 5- to 16-year-old slash, loblolly, and longleaf pine plantations in the Alabama Coastal Plain. The correlation of soil and other site factors with height growth has been studied.

Regression equations for estimating the heights of the tallest trees were developed. The equation adopted for slash pine, ages 5 to 16 years, was:

Height of tallest trees = –11.94 + 5.11(Age) + 0.00929(Depth of topsoil × silt plus clay of topsoil) – 0.1127(Age^2)

The equation adopted for loblolly pine, ages 5 to 16 years, was:

Height of tallest trees = –14.91 + 5.96(Age) + 0.00818(Depth of topsoil × silt plus clay of topsoil) – 0.1725(Age^2)

Age alone was as good a predictor of height of longleaf pine, ages 8 to 16 years, as could be found. Height of tallest trees = 2.44 + 2.385(Age).

In no case were mineral nutrient element concentrations of the top 6-inch soil layer found to be closely correlated with height growth either when considered alone or with soil physical and climatic variables held constant.

Regression equations for estimating the merchantable volume in cords of rough wood per acre were developed. The equation adopted for slash pine was:

Merchantable Volume = –30.46 + 1.0196(Height of tallest trees) + 0.013213(Number of trees per acre)

The equation adopted for loblolly pine was:

Merchantable Volume = –22.06 + 0.9661(Height of tallest trees) + 0.002724(Number of trees per acre)

The equation adopted for longleaf pine was:

Merchantable Volume = –20.45 + 0.7756(Height of tallest trees) + 0.006304(Number of trees per acre)

These equations when used with the equations for estimating height allow one to estimate the early volume production of bare old fields in the study area if they are to be planted in pines.

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