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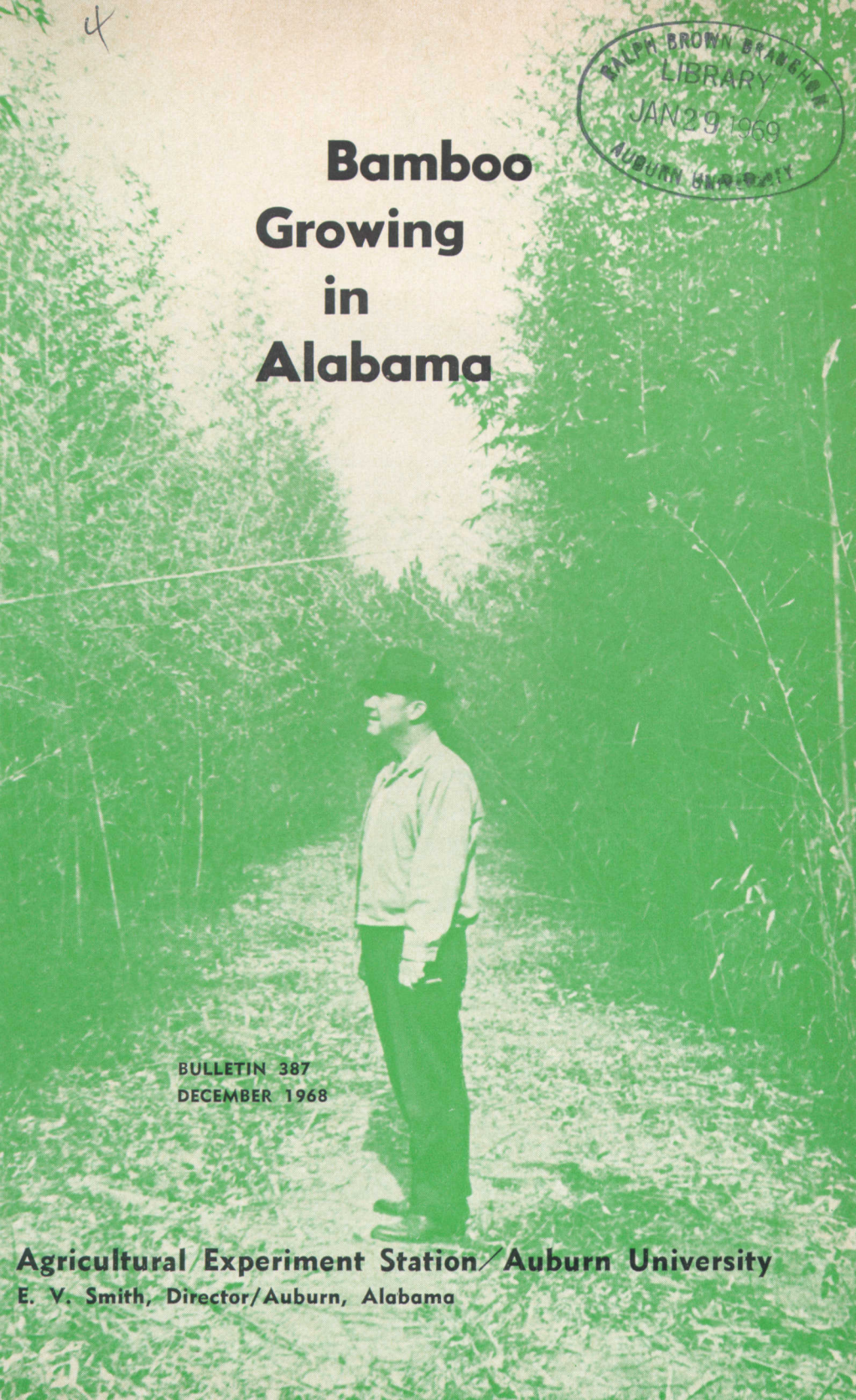
Bamboo Growing in Alabama



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CONTENTS

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Bamboo Growing in Alabama

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BAMBOO IS AN IMPORTANT crop plant in the Orient. Fish poles, plant stakes, yard rakes, furniture, shades, and other articles manufactured from bamboo are imported from China, Japan, and other oriental countries. Oriental bamboo has been grown in small areas in Alabama for many years and used locally for stakes, poles, shades, and other purposes. Some varieties have been grown as ornamentals.

Increased interest in fishing, beginning in the 1930's, created an expanded market for bamboo fish poles and suggested bamboo as a possible new crop for Alabama. Prospective growers, however, had no source of information relative to adapted varieties nor cultural requirements. Consequently, experiments with bamboo were initiated at the Main Station at Auburn in 1933.

Two developments in the late 1950's and early 1960's further stimulated interest in bamboo. One was the search for new crops for industrial uses that might substitute for or complement crops then in surplus production. The other was the rapid development of the pulp and paper industry. These developments were responsible for the initiation of extensive experiments with bamboo at the Lower Coastal Plain Substation, Camden, in 1959.

In addition to formal results obtained from planned experiments, a body of valuable knowledge concerning the cultural requirements and biology of bamboo was acquired.

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* Project leader for all bamboo experiments of Auburn University Agricultural Experiment Station. Cooperation of W. B. DeVall and E. J. Hodgkins, Department of Forestry, in the bamboo-pine experiment is acknowledged. Also, cooperation of C. O. Erlanson, J. R. Haun, and W. O. Hawley, of U.S. Department of Agriculture, Agricultural Research Service, Crops Research Division, New Crops Research Branch, Crop Development Section, in planning the tests and supplying planting stock of bamboo is gratefully acknowledged.

** Co-investigators with Sturkie in the Lower Coastal Plain Substation portion of the bamboo experiments.

BIOLOGY AND CULTURAL REQUIREMENTS

Botany of Bamboo

Bamboos are true grasses, characterized by hollow or rarely solid stems closed at the joints, or nodes. They have been known and used since ancient times, but their botanical characteristics and relationships are not fully understood. This results in large measure from the fact that most bamboos are extremely slow in flowering and producing seed.

There are two types of bamboo grown in this country: (1) clump type and (2) running type.

The clumb type spreads by short rhizomes that produce new canes near the base of the old ones. These are usually of tropical origin and do not thrive in Alabama except along the coast. This type of bamboo is often planted for hedges or singly for specimen plants. It spreads slowly and is easily kept within bounds. All of these bamboos tested at Auburn have been killed back to the ground many times and most of them have been completely killed. The only one surviving in 1968 is *Bambusa multiplex var. stripe stem fernleaf* PI No. 99289. It is defoliated nearly every winter, but new leaves put out the following spring. During several winters the stems were killed back to the ground, but new canes developed the following year from buds or rhizomes.

The running type is much hardier than the clump type. It produces rhizomes that grow in all directions and may extend for 15 feet or more each year. Thus, it is difficult to confine to a given area.

The running bamboos grow much farther north than the clump bamboos. Some of the species are suited to growth in all areas of Alabama. Most introduced (commonly called "Japanese") bamboo belongs to the genus *Phyllostachys. Semi-arundinaria* and a few other genera have occasionally been planted. The "native cane" (bamboo) is *Arundinaria.* Occasionally found along streams, the Arundinarias occurred at one time in abundance over much of the South in areas known as canebrakes.

Plants of bamboo vary in height from a few inches to a giant size of 70 feet. Plants usually have upright stems with prominent nodes. The internodes vary in length and are usually hollow but are solid in some varieties. In most cases branches occur only at the upper nodes, the remainder of the plant being a long, slender, strong cane, which is the portion of the plant most often used.

The plants have a dense fibrous root system and produce rhizomes having buds at irregular intervals along the side.

The rhizomes are heavy, short jointed, often branching underground runners. They are essential for storage and translocation of nutrients. The buds give rise to new culms (canes or plants) or new rhizomes. Usually only a few of the buds along a rhizome begin growth (sprout) in the spring. Most buds remain dormant and may live for 5 or 6 years before they die. Germination of buds on the old (5 or 6 years) rhizomes is very poor. On first-year rhizomes, germination of buds is poor unless attached to the mother plant.

New rhizomes begin to develop about June and continue growth during mid-summer and early fall. The buds on rhizome-nodes swell slowly and continuously for several months. They emerge as new plants when the warm weather of spring arrives. The period of sprout emergence varies according to species, vigor of the mother bamboo, and environmental conditions. Even in one bamboo grove, there are variations of 50 to 60 days between early and late spring sprouting. Sprouting is also affected by moisture, decreasing in dry weather. Although it has been reported that buds sprout poorly following mild winters with few or no hard freezes, the winters at Auburn were always severe enough to induce normal sprouting.

Closeup of bamboo showing growth of shoots in early spring.

It appears that the number of buds sprouting varies with the species of bamboo. In plantings at Camden, some species produced much better stands than others from the same number of rhizomes. *Phyllostachys rubromarginata* produced better stands than did *P. bambusoides, P. viridis,* or *P. vivax.*

The bud from which the new bamboo culm grows appears on the side of the rhizome as a small, hard swelling. As the warm weather of spring arrives, this bud begins to lengthen and expands into a compact upright growth until its point pierces the ground.

The new culm first makes its appearance above ground as a sharp point, and develops slowly upward for the next few days. An interesting feature of bamboo growth is that the entire length of the cane is compressed into the sprout when it first makes its appearance above ground, the elongation being from the bottom up; that is, the bottom joints or internodes elongate much more rapidly than those above, and cease growing only when they reach their ultimate length. There is no increase in girth of the bamboo culm after it appears above ground, but the culm elongates joint by joint until it reaches its maximum height. Elongation is slow for the first 2 or 3 feet, but the height growth from then on is exceedingly rapid to maturity. For example, timber bamboo growing from mature rhizomes completes its height, which may be as much as 55 feet, in 6 weeks, the average time in which all bamboo shoots reach maximum height. At this time the plant sends out branches from the nodes near the top. These produce leaves and the plant has completed its growth except for filling of the culm. The walls harden for about 2-3 years, when the bamboo culm is completely mature.

The plant sheds its leaves each summer by putting out a new crop from buds in the axil of the old leaves. Old leaves drop gradually, so the change from old to new leaves is hardly noticeable. The age of a bamboo culm can be determined by the number of leaf scars on a branch (twig). A year-old culm would have no leaf scars, a 2-year-old would have one, and a 3-year-old one would have two scars.

The first year after planting bamboo, culms are only a few feet in height. Culms originating during each succeeding year grow a few feet taller than those of the year before until the ultimate height for the species is reached. For the larger varieties this is usually 15 to 20 years. It usually requires 7 or 8 years after planting before canes large enough to be of use are produced.

The flowering and production of seed is a curious and interesting feature of bamboo. When this event occurs, many species die. Whole forests may die, requiring several years for the seedlings or vegetative parts to repopulate the region. Another phenomenon associated with bamboo is the simultaneous development of flowers. All plants of the same species, regardless of age or size, over a wide region will bloom at one time. Plants flower for 2 or 3 years and then die. A few buds usually survive at the base of a plant. The plant must be reestablished from seed or from buds that did not die.

This peculiarity of bamboo is of prime importance from an economic standpoint, for it would be unfortunate after spending time and money in the development of plantations suddenly to find the whole destroyed or so weakened that several years would be required to reestablish them. The flowering is rare, occurring only once in many years.

In reestablishing bamboo after it has seeded, some small shoots appear. These should be left for the first 3 years at least. All the shoots that appear should be allowed to mature. After the grove is once reestablished, only the largest shoots should be permitted to grow, the others being cut as soon as they appear. This thinning process concentrates plant growth into a comparatively few large culms and gradually increases the height and strength of the forest. At Auburn since 1933, three bamboos have flowered, recovered, and reestablished themselves. The whole process required about 6 years.

Soils

Bamboo in general requires a moderately moist, well-drained soil of good fertility for best growth. Preferred soils are loams, with best growth made on moist bottom lands. Good drainage is essential, as bamboo will not tolerate a water-logged condition. Bamboo at Camden on river terrace soil has withstood flooding by flowing river water for a few weeks without being killed. Most any upland soil can be used to produce bamboo if it is fertilized. Watering is desirable for maximum growth, but the plant can stand long periods of drought. The hardy species stood severe droughts at Auburn and at Camden without dying, but growth was retarded.

Bamboo has grown at Auburn on eroded Cecil clay soil, but growth was better on uneroded Cecil sandy soil. At Camden,

bamboo has grown well on Wickham sandy loam in the river terrace and on Norfolk fine sandy loam on the hills.

Climate

Some kinds of bamboo are adapted as far north as Pennsylvania. Others are killed by freezing temperature, hence are only suited to tropical climates. The hardy bamboos will withstand the climate anywhere in Alabama. Temperatures of 5°F may kill the leaves, but new leaves will come next spring or the plant will come back from new shoots. The rhizomes are not killed. Leaves usually remain green throughout winter.

At Auburn, a temperature of 17°F on March 26, 1955, killed the leaves of several species of bamboo and the culms of several species. In this instance the sudden cold followed a warm period in which the bamboos had begun active growth. The species damaged most had already developed new shoots. In previous winters, they had experienced lower temperatures without damage to the leaves. Some species are defoliated most winters at Auburn, whereas others are seldom damaged. *Phyllostachys rubromarginata* and *Semi-arundinaria fastuosa* have never been damaged at Auburn, and *Phyllostachys viridis* only once in 20 years.

Propagation and Culture

When all conditions are right, bamboo plants are easily propagated. When conditions are not right, however, little success will be obtained. Principal methods of propagating bamboos are (1) by division or splitting up the clumps, and (2) by cutting off and planting the rhizomes.

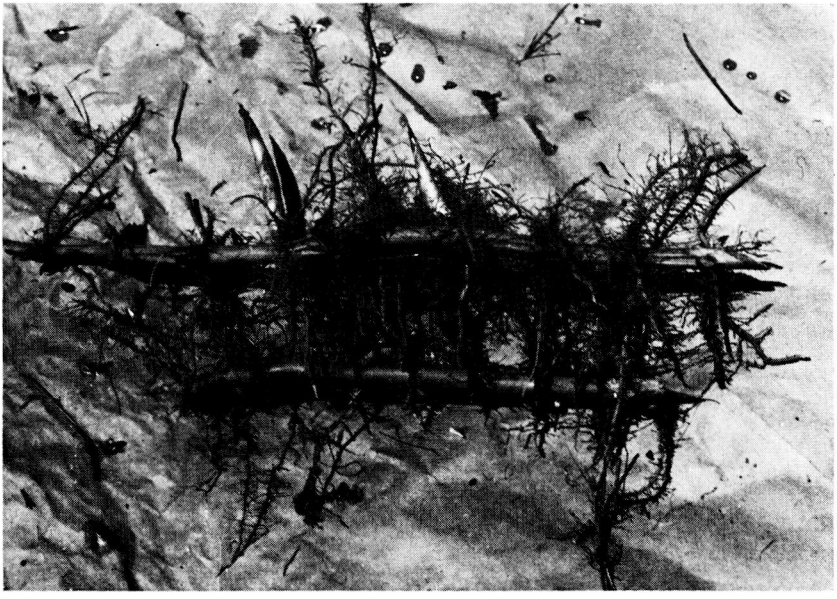
Division of Clumps. If a young clump of any of the running bamboos is examined in early summer, young plants will be found coming up on the edges of the clump. These young plants are attached to rhizomes, which go back to an old plant. On the rhizomes will be found young plants and dormant buds or shoots. If the plant, together with a piece of the rhizome, is carefully removed with a ball of the soil, this makes a good young clump for propagation purposes. The proper time to dig these young plants is in early spring before growth begins. Then it is only a matter of transporting this clump to a new area and setting it out.

A divided plant, such as described, if properly cared for will make a fair growth the first year and will usually send out new

rhizomes from which several plants will develop the next year. This is the most satisfactory type of plant to use for propagation purposes. If the rhizomes are strong, the buds sound, and the stems and roots satisfactory, growth will start promptly and be maintained steadily if soil and other conditions are right.

The divided plants will not stand long distance shipment unless great precautions are taken. These usually weigh 10 to 15 pounds per clump, thus making the cost nearly prohibitive. Therefore, this method of propagation is suitable for moving only short distances.

CUT RHIZOMES. Bamboo plants develop numerous rhizomes about 2 to 6 inches underneath the ground, which may extend 10 to 20 feet from the mother plant. They have numerous roots and develop buds at frequent intervals. Rhizomes used for propagation should have buds that are bright, and roots growing from the nodes should be bright and vigorous. Rhizomes that are dark in color with dark buds and few vigorous roots are old and not suited for propagation. Two-year-old rhizomes, if carefully removed and washed, make good propagating material and are preferred. Each viable bud will develop into a plant, which in turn will develop roots and send out other rhizomes. These rhizomes are relatively



These rhizomes are washed free of soil and cut ready for planting.

Bamboo from planting rhizomes: top, first year; bottom, second year.

light and may be shipped long distances at low cost. They should be kept moist and cool during shipping and never be permitted to dry out.

The proper time to lift and divide the rhizomes is in February, March, or early April, just before the buds begin to push (grow up forming plants). Failure will likely result if the rhizomes are not lifted at the proper time.

ESTABLISHING AND MAINTAINING A NURSERY. A nursery is almost indispensable if large quantities of planting stock are needed. The nursery soil should be a rich fertile loam. It should be well prepared and irrigation provided to take care of the young plants. The rhizomes should be cut in 12- to 15-inch sections, planted in trenches, covered about 3 to 4 inches, and the soil firmed around them. Immediately after setting, they should be moistened and the soil kept moist at all times. Mulching is highly desirable.

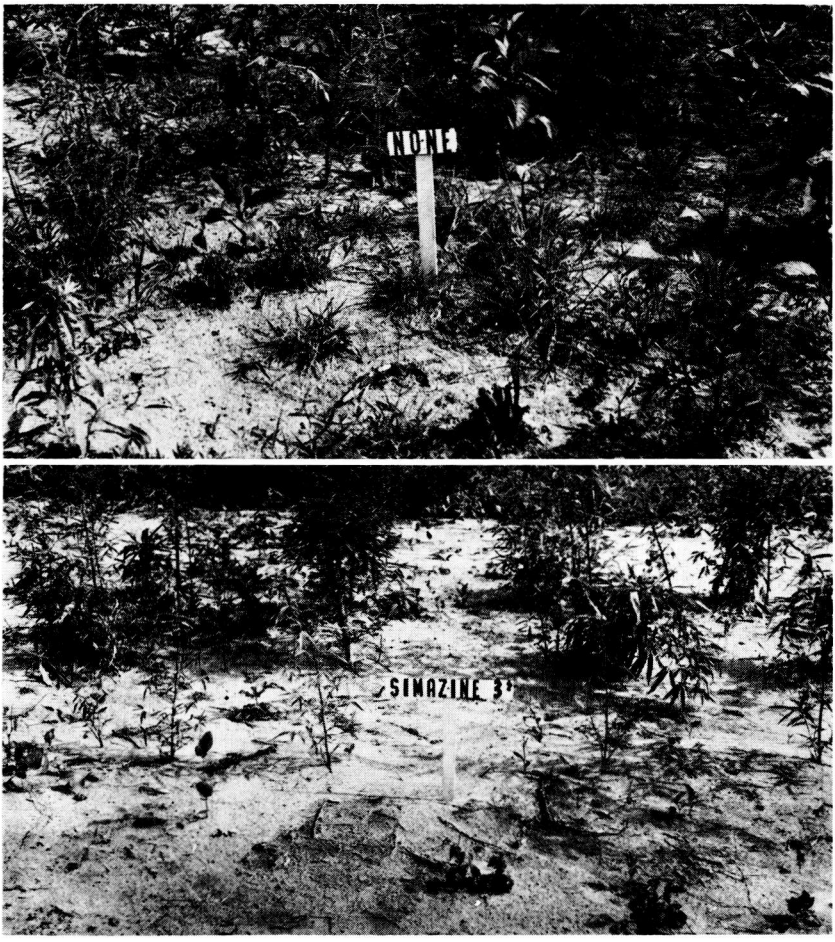
One hundred properly selected rhizomes will weigh 3 to 5 pounds. Under favorable conditions, 50 per cent germination may be expected, so the 100 rhizomes should produce 50 good plants.

Careful weeding and watering during dry spells are needed the first summer. Plants usually attain a height of 1 to 3 feet the first year. At the beginning of the second year the plants may be dug and transplanted to permanent areas. If the nursery is to be used as a permanent source of planting material, it should be left 2 or 3 years to develop rootstocks before beginning digging. In digging, enough rhizomes are left to reestablish the nursery.

A good fertilizer program for a nursery is 80 pounds N, 35 pounds P (80 pounds P_2O_5), and 50 pounds K (80 pounds K_2O) per acre worked into the soil before setting rhizomes. Apply 200 pounds of ammonium nitrate per acre about June 15 and again about September 1. The second year, 80 pounds N, 35 pounds P, and 50 pounds K per acre are broadcast before growth begins in the spring and ammonium nitrate applications are repeated during the summer as in the first year. This treatment is needed each year as long as the nursery is in use.

Weeding should be done carefully so as not to damage the rhizomes. Most of the weeding will have to be done by hand pulling or use of herbicides. Do not hoe around the young plants, because this will damage the rhizomes.

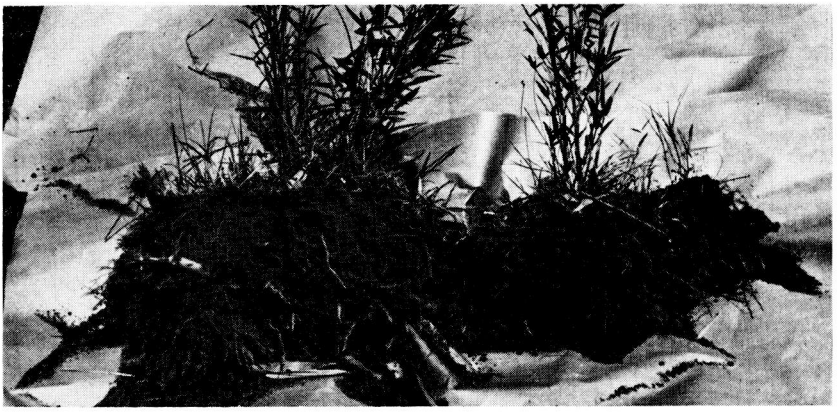
Excellent control of annual grasses and weeds was obtained at Auburn and at Camden by spraying with simazine at the rate of 3 pounds active ingredient per acre after the rhizomes were set. One application controlled the broadleaf weeds and grasses until about July 1. Another application of about 1 pound per acre was sometimes necessary to control the weeds until frost. No damage was apparent to the bamboo plants.



Simazine weed control: top, untreated plot; bottom, 3 pounds simazine per acre immediately after planting March 15, 1961 (photographed June 13, 1961).

Setting Permanent Areas

For planting large areas it is desirable to use clumps of plants from a nursery. Plants survive better and require less care than do rhizome cuttings. Rhizome cuttings may be used for small areas. The plants should be removed from the nursery and set in February or March when soil is moist. If the plants in the nursery are too tall, cut them back for easy handling. It is desirable to dig a hole larger than the divided clump with its attached roots and soil. Set the plants a few inches lower than they grew in the nursery. Carefully fill the hole so as not to damage the buds on



Bamboo plants grown in nursery and dug with soil attached ready for planting.

the rhizomes. The hole should not be completely filled, leaving a depression to hold water. Watering plants to settle the soil around the roots is desirable.

SPACING OF PLANTS. Spacing will vary with purpose of the planting, cost of planting material, and the earliness desired to cover the area. Developing a grove or a plantation requires 10 to 15 years to bring the plants to a desirable size. Bamboo culture is slow work and little can be done to speed up the development. Therefore, little can be gained by going to the expense of close plant spacing. Planting 15 to 20 feet apart in each direction has been satisfactory at Auburn and Camden. On the other hand, a planting for a hedge or screen or for ornamental purposes can be brought to the desired use rapidly by a spacing of 2 or 3 feet.

CARE AFTER PLANTING: If possible, protect bamboo from drought and competing vegetation. During the first year after planting water every 7 to 10 days when there is no rain. In large plantings, weeds and grass between rows of plants may be kept at a minimum size by mowing frequently or using herbicides.

FERTILIZATION. Apply a complete fertilizer such as 80 pounds N, 35 pounds P, and 50 pounds K per acre.

PRUNING HEDGES. Hedges should be pruned once or twice a year. Canes are allowed to grow to their full height in the spring, and then cut back to the desired height before the branches put out leaves. Cut the canes 1 or 2 inches above a node and branches on the sides of the hedge to the desired length.

THINNING GROVES. Thinning is necessary to produce desirable

canes for market or home use and for best appearance. A grove should be thinned when the plants have covered the area and reached a height of 15 feet. Thinning should be done in the winter, and never when new shoots are putting up since they are easily broken and damaged. The first thinning should consist of removing the small canes and crooked canes, leaving enough canes to shade the ground. Never thin enough to allow the sun to dry soil around the plants. If too many canes are cut and large spaces exist, the stems turn yellow, good canes decrease in number, and the planting becomes thin and impoverished. If canes are unthinned, the plants get too thick and are small in size and the grove becomes filled with dead, fallen, and poorly shaped canes and does not present a handsome appearance.

Culms 1-2 years old have thin walls and do not produce desirable poles. The best poles are from 3- to 4-year-old culms. It is not advisable to leave stems older than 4 or 5 years, therefore older canes are always removed in thinning. Never remove more than one-fourth of the canes at one time. Some system of marking the new canes each year is desirable so that age of the cane can be determined at time of thinning. A well managed grove has stout, well shaped canes with a dense dark green foliage that is attractive. The fallen leaves accumulate and decay naturally, producing a constant supply of humus that holds moisture and fertility. The grove will furnish a continuous supply of poles that may be harvested each year. Thinning would not be practical if bamboo is grown on a large scale for pulp.

Harvesting by sawing canes is better than cutting with an axe. Cutting leaves sharp points that do not decay for several years and are thus dangerous to anyone working in the grove.

Uses

Bamboo has many uses in the Orient where it is intimately associated with the lives and economy of the people. Currently, its uses are more limited in the United States.

ORNAMENTALS. Since the species vary so widely in size, they afford many uses as ornamentals varying from shades to screens to small base plantings around a dwelling. Bamboo is an evergreen plant and makes an excellent screen. Since species vary so much in height, a screen can be almost any height from 2 feet to 50 feet. Also, pruning of large species permits height control and variable shapes and heights of screens.

STAKES. Bamboo is resistant to termites and stakes will last several years. It makes excellent plant stakes for flowers, tomatoes, beans, and other plants.

POLES. Bamboo is the best plant known for fish poles or poles for knocking pecans or other nuts from trees. Thousands of poles are harvested and used in Alabama each year. The poles can be used in the manufacture of furniture and other articles and for buildings, such as tea houses in gardens.

WIND BREAKS. Bamboo is an excellent plant for wind breaks. It will withstand violent winds and, growing thick, will prevent wind damage to other plants.

FOOD. Young shoots of many bamboos are edible. They are imported into this country and used extensively in cooking, particularly in Chinese foods.

GRAZING. The leaves of bamboo are edible and animals graze on them when they have access to them. The "switch canes" (*Arundinaria tecta*) have been grazed during the winter for many years in Alabama and other areas of the South.

PAPER PULP. Bamboo fibers have excellent qualities for paper making. Used extensively in the Orient for this purpose, it has possibilities for extensive use in this country.

EXPERIMENTS IN ALABAMA

Experiments with bamboo have been conducted at Auburn since 1933 when the first introductions were made from several nurseries in the United States, particularly the U.S. Plant Introduction Station at Savannah, Georgia. Numerous introductions have been made. Those that have grown successfully are listed in Table 1.

Large scale experiments at Camden were begun in 1959 when a planting of approximately 4 acres of timber bamboo was made to compare yields of bamboo and pine for pulp production. In 1960, approximately 100 acres of five species was planted to study the problems of production, harvesting, and utilization of bamboo. These experiments were initiated with the active cooperation of the New Crops Research Branch of the United States Department of Agriculture. The discontinuation of cooperation by the Department on July 1, 1965, reportedly as an economy

TABLE 1. BAMBOOS THAT HAVE GROWN SUCCESSFULLY AT AUBURN, ALABAMA

Species		Source	Plant Introduction No.
Scientific name	Common name		
Arundinaria amabilis	Tonkin cane	USDA	110,509
Arundinaria angustifolia	----------	USDA	129,301
Arundinaria gigantea	Canebreak bamboo or southern cane	local	-----
Arundinaria nagashima	----------	USDA	75,149
Arundinaria simonii (tall)	Simon bamboo	USDA	142,492
Arundinaria simonii (short)	----------	USDA	75,151
Arundinaria tecta	Switch cane	USDA	153,804
Arundinaria tecta	Switch cane	USDA	153,807
Arundinaria tunghomii	----------	USDA	139,883
Arundinaria viridi-striata	----------	USDA	75,161
Bambusa multiplex[1]	var. stripe stem fernleaf	USDA	99,289
Phyllostachys aurea	Fish pole bamboo or Todd's bamboo	local	-----
Phyllostachys aureosulcata	Yellow groove bamboo	USDA	55,713
Phyllostachys bambusoides	Timber bamboo	USDA	40,842
Phyllostachys bambusoides var. castilloni	Castillion bamboo	USDA	42,659
Phyllostachys flexuosa	----------	USDA	116,965
Phyllostachys flexuosa	----------	USDA	52,686
Phyllostachys makinoi	----------	USDA	195,284
Phyllostachys meyeri	Meyer bamboo	USDA	116,768
Phyllostachys nidularia	----------	USDA	-----
Phyllostachys nigra	Black bamboo	USDA	66,784
Phyllostachys nigra var. henon	Henon bamboo	USDA	24,761
Phyllostachys rubromarginata	----------	USDA	66,902
Phyllostachys viridis	----------	USDA	77,257
Phyllostachys vivax	----------	USDA	82,047
Sasa palmata	----------	USDA	75,169
Semi-arundinaria farinosa	----------	USDA	77,004
Semi-arundinaria fastuosa	Nahiria bamboo	USDA	52,671
Shibataea kumasaca	Ruscus leaf bamboo	USDA	75,157

[1] Clump type.

measure, resulted in drastic curtailment of planned harvesting research and abandonment of plans for utilization research.

Experiments at Auburn

The tests have consisted of observations on appearance, growth habits, cold tolerance, and yields from cutting treatments.

COLD TOLERANCE. Most cold tolerant species were *P. rubromarginata, S. fastuosa,* and *P. viridis.* Next in tolerance were *P. aureosulcata* and *P. nigra var. henon. Phyllostachys bambusoides, P. meyeri,* and *P. aurea* have been damaged severely 3 years in the 20 years they have been observed.

YIELD OF POLES. Seven species have been harvested for marketable poles. The age at harvest varied from 8 to 18 years. Yields reported in Table 2 are for canes 15 feet or longer. (Those less

Bambusoides bamboo at Auburn, Alabama; closeup (bottom) shows size of canes.

than 15 feet are not marketable.) Production per acre has varied from 11,000 to 39,000 canes. Yields with selective cutting have varied from 2,000 to 10,000 per acre per year. The production of very large poles from the large species, such as *P. viridis*, *P. vivax*, and *P. bambusoides*, would be less; probably about 1,000 per acre would be about the maximum that one could expect to harvest and maintain the grove.

TABLE 2. YIELD OF POLES PER ACRE 15 FEET OR LONGER OF VARIOUS BAMBOO SPECIES WHEN ALL[1] CANES WERE CUT, AUBURN, ALABAMA

Species	Common name	Years harvested	Poles 15 ft. or longer per acre
		No.	*No.*
Phyllostachys aurea	Fish pole bamboo or Todd's bamboo	1	33,189
Phyllostachys aureosulcata	Yellow groove bamboo	4	22,493
Phyllostachys bambusoides	Timber bamboo	4	11,616
Phyllostachys meyeri	Meyer bamboo	1	26,602
Phyllostachys nigra var. henon	Henon bamboo	3	26,862
Phyllostachys rubromarginata	----------	7	39,471
Semi-arundinaria fastuosa	Nahiria bamboo	1	21,732

[1] Normally one would not cut all canes on an area at one time. Usual harvest would cut about one-third or one-fourth of the large canes at one time. All of the canes were not marketable as poles because some were crooked and not suitable except to be cut in short lengths for stakes.

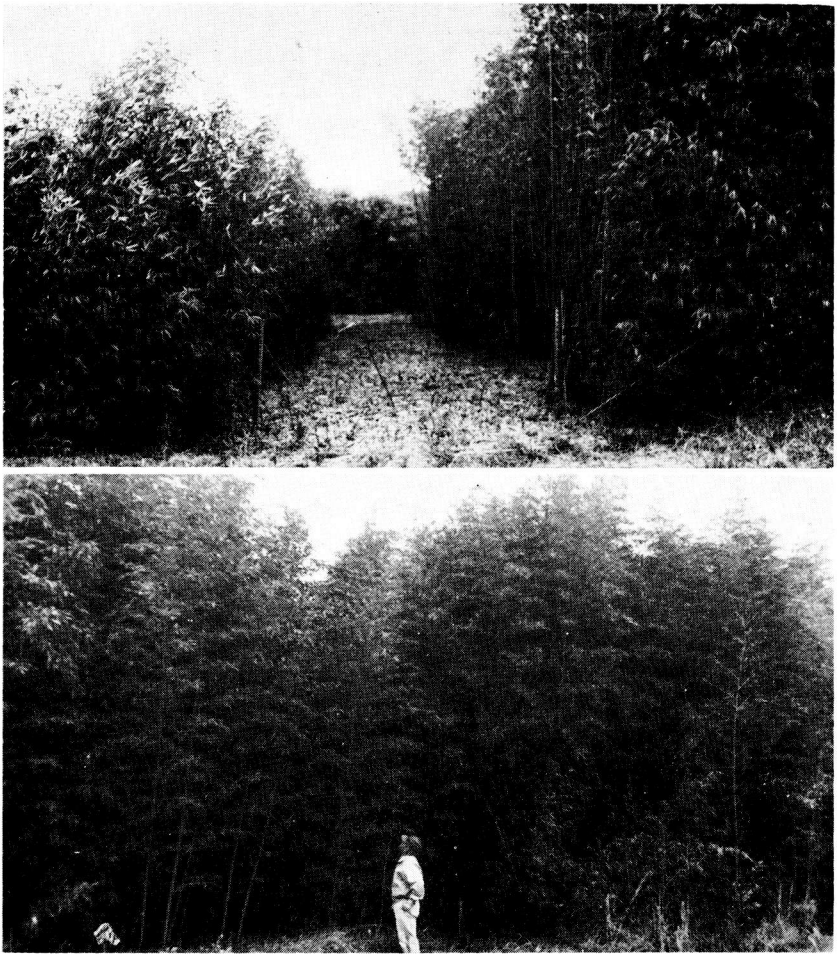
YIELD OF WOOD. Yields of five species of bamboo harvested for wood (suitable for pulp) reported in Table 3 are for all canes on an area. Age of bamboo varied from 15 to 20 years, with average yield of 17-54 tons per acre. *Phyllostachys rubromarginata* has been the most productive species tested at Auburn. It has smaller canes than the timber bamboo, but has many more canes per acre; thus, total production is much larger.

The percentage weight of leaves on a green plant has varied from 10 to 16 per cent, with limbs making up 11 to 20 per cent. It is believed that if bamboo were grown for pulp, the limbs would not be removed and would be used in the pulping process; hence the dry weight reported is the total for limbs and stems.

TABLE 3. YIELDS OF DRY WOOD, PER CENT BRANCHES, PER CENT DRY MATTER, AND PER CENT LEAVES IN VARIOUS BAMBOO SPECIES, AUBURN, ALABAMA

Species	Year planted	Harvest year	Leaf content of green plant	Dry weight	Total dry wt. that is branches	Per acre dry wt. with branches
			Pct.	*Pct.*	*Pct.*	*Lb.*
Phyllostachys aurea	1944	1959	15	68	16	39,366
Phyllostachys aureosulcata	1944	4-yr. av. 1960-63	16	59	20	34,326
Phyllostachys bambusoides	1944	4-yr. av. 1951, '57 '61, '62	13	62	21	44,607
Phyllostachys meyeri	1944	1959	10	61	11	77,591
Phyllostachys rubromarginata	1946	7-yr. av. 1960-66	13	65	14	108,352

CUTTING IN STRIPS FOR WOOD. Observations of *P. bambusoides* at Auburn showed a much slower recovery when an area was solid cut than when it was cut in strips 5 feet or 10 feet wide. A study was begun in 1960 using *P. rubromarginata* to determine the yield when strips 10 feet wide were cut in a north-south direction. Yields for the first cutting were about twice as large as from the second cutting, Table 4. The bamboo was 14 to 19 years old at the first cutting, but the canes were only 5 years old when the second cutting was made. Yield per acre per year of growth is much in favor of the strip cutting.



Top, Bamboo cut in 10-foot strip; bottom, regrowth of strip year after cutting.

TABLE 4. YIELDS OF DRY WOOD PER ACRE OF PHYLLOSTACHYS RUBROMARGINATA WHEN STRIPS 10 FEET WIDE WERE CUT AND RECUT AGAIN 5 YEARS LATER, AUBURN, ALABAMA[1]

Year when cut		Yield per acre dry wood		
First cut	Second cut	First cut	Second cut	Total
		Lb.	*Lb.*	*Lb.*
1960	1965	120,382	41,536	161,918
1961	1966	116,311	37,278	153,589
1962	1967	119,271	89,848	209,119
1963	1968	82,950	58,721	141,671
AVERAGE		109,729	56,846	166,575

[1] All plantings were made in 1946.

It is not known what the maximum width of the cutting strip should be. Ten feet was used because it was known from past cutting that the bamboo would recover in at least a 10-foot strip. Young plants coming up in the cut strip appear to draw on the mother plants on each side for food, thus growing faster than when no mother plants are present.

It is not known whether there is any growth difference because of direction in which a strip is cut. Cutting east and west should allow more sunlight to reach young plants.

Experiments at Camden

PLANTING STOCK TEST. The 1960 planting at Camden included 100 acres of five species and two kinds of planting stock (plants and rhizomes). The area was river terrace soil and varied from clay to sandy loam in texture. Planting stock was supplied by the Plant Introduction Station at Savannah, Georgia. Grown, dug, and processed at the station, it was shipped by truck at various times to Camden. It was stored in moist sawdust and planted as soon as possible after arriving. It appeared to be good, live planting stock.

The planting was done in well prepared soil from January 21 to April 26. Planting was by hand at a depth of 4-5 inches spaced 16 feet in each direction. The plants were watered during the summer of 1960 as frequently as possible, but it was not possible to water as often as needed. Weeds were kept down by hand hoeing a few feet around each plant and middles were kept mowed.

Counts of surviving plants made in fall 1960, Table 5, show much better survival of plants than rhizomes for the three species where a comparison could be made.

TABLE 5. PER CENT LIVE PLANTS OBTAINED WHEN PLANTS OR RHIZOMES WERE USED FOR PLANTING STOCK[1] OF VARIOUS BAMBOO SPECIES AT CAMDEN, ALABAMA, 1960

Species	Number planted		Survival	
	Plants	Rhizomes	Plants	Rhizomes
			Pct.	*Pct.*
P. bambusoides	2,184	312	38.6	3.0
P. nigra var. henon	-----	156	-----	31.0
P. rubromarginata	-----	156	-----	86.0
P. viridis	4,680	936	24.3	0.7
P. vivax	3,120	2,496	19.0	1.0

[1] Planted January 21 to April 26, 1960.

Phyllostachys rubromarginata and *P. nigra var. henon* had much better survival from rhizomes than the other three varieties. It is not known if this is a species characteristic. In plantings made in subsequent years, *P. rubromarginata* has had a remarkably high percentage of survival.

Phyllostachys rubromarginata at Camden, Alabama, 5 years after planting rhizomes.

YIELDS OF WOOD. Yields of wood of three species determined in 1966 and 1967 by cutting strips 10 feet wide across plantings made in 1959 and 1960 show a decided advantage for *P. rubromarginata,* Table 6. The weights are for stems and branches and are assumed to be the yields that would have been obtained if the bamboo had been cut for pulp.

TABLE 6. BAMBOO YIELDS AT LOWER COASTAL PLAIN SUBSTATION, CAMDEN, ALABAMA

Species and planting site	Year planted	2-year average yield, 1966-67		
		Poles 15 ft. or longer	Dry weight	Dry wood[1] per acre
		No.	*Pct.*	*Lb.*
Upland, Norfolk f.s.l.				
P. bambusoides	1959	6,516	52	31,645
River terrace, Wickham s.l.				
P. bambusoides	1959	7,938	52	47,305
P. rubromarginata	1960	24,410	57	73,788
P. viridis	1960	4,550[2]	63[2]	21,689[2]

[1] Oven-dry basis of weight of stems and branches, leaves were removed.
[2] One year—1966.

BAMBOO AND PINE COMPARISON. In 1959, plantings of timber bamboo (*Phyllostachys bambusoides*) and loblolly pine (*Pinus taeda*) were made on river terrace soil (Wickham sandy loam) and upland soil (Norfolk fine sandy loam) to compare the production of pulpwood. Plots were 216 feet × 216 feet and plants were set 8 feet × 8 feet. Good stands of pine and bamboo were obtained.

The first yield records were made in December of 1966. These yields, reported in Table 7, are calculated on basis of cutting all the plants (not selective cutting). Strips were cut for records (10 feet for bamboo and 8 feet for pine), and the remainder left for records of future cuttings. Pine yields (8 tons per acre) are on the basis of bark-free wood and the 14-ton yield of bamboo is of leaf-free branches and stems.

Loblolly pine (left) and bamboo at Camden, Alabama, 8 years after setting.

TABLE 7. DRY WOOD PRODUCED PER ACRE BAMBOO AND PINE AT CAMDEN, ALABAMA, ON RIVER TERRACE (WICKHAM SANDY LOAM SOIL), 1966

Crop	Date set	Date cut	Yield, oven-dry wood per acre
			Lb.
Pine Loblolly (*Pinus taeda*)	1959	Dec. 1966	15,870[1]
Bamboo *Phyllostachys bambusoides*	1959	Dec. 1966	27,749[2]

[1] Bark-free wood.

[2] Weight of stems and branches, free of leaves.

Place for Bamboo in Alabama

POLES AND STAKES. There is a place for bamboo on many farms to be used for poles and stakes. In some cases they are bought by firms that process and sell fishing poles, which have a ready market. Others are bought for use in harvesting pecans. The best species for fishing canes are *P. aurea* and *P. meyeri. Phyllostachys bambusoides* may be used, but it should be cut so as to keep the poles short (15-18 feet). The preferred species is *Phyllostachys aurea,* which has many canes with short joints near the base that make for very desirable poles. For stakes, *P. aurea, P. meyeri, P. bambusoides, P. nigra var. henon,* and *P. rubromarginata* are excellent.

Fish pole bamboo at Auburn, Alabama.

Closeup of fish pole bamboo shows desired short joints near base.

HEDGES. Any of the species can be used for hedges if they are pruned correctly. Pruning can be avoided by using a smaller species. One of the best for a hedge 4 to 6 feet high is *Shibataea kumasaca.* Another good species is switch cane (*Arundinaria tecta*). For a hedge 8 to 12 feet tall, *Arundinaria simonii* (small type) or *Arundinaria gigantea* are excellent if pruned occasionally.

ORNAMENTAL AND SHRUBS. A few of the bamboos are small and make excellent plants for use around the home as ornamentals. *Arundinaria viridi-striata* grows 2-3 feet tall and has a yellowish striped leaf. It grows well in the shade. *Sasa palmata,* with a broad long leaf that is bright green in color, makes an excellent appearance. It grows 4 to 6 feet in height, but can be kept smaller by pruning.

BAMBOO FOR WOOD PULP. Bamboo is better suited than pine for certain paper products, such as facial tissues and fine writing paper. This is because the bamboo fiber has a much greater length-to-width ratio than pine fiber. This property gives added flexibility to bamboo-made paper, imparting softness and smoothness to the final product. The yields reported, Tables 3, 4, 6, and 7, show that bamboo would produce well in certain areas of Alabama. It would be limited to areas not too cold, probably where temperatures do not drop below 5°F. Many soils of the State are suited to bamboo.

Bamboo spreads by rhizomes and is a perennial. Thus, it will

grow continuously after cutting without having to be replanted. If a rotational system of cutting is used, a portion of the stand may be harvested each year after the plant is established. To lessen the risk of loss when a species produces flowers, several species should be grown.

Before bamboo can be successfully grown as a crop for pulp production, several problems need to be solved:

1. Large-scale methods of propagation will have to be developed to get large acreages under production.

2. Harvesting and handling of the cane must be mechanized. Studies are needed to determine the maximum width of cut that will maintain the stand. A width of 10 feet has worked satisfactorily in studies in Alabama. It is not known how much wider widths might be used. How frequently these strips should be harvested to produce the maximum pulp per acre per year needs to be determined. Studies comparing productivity under clean cutting and strip cutting are needed.

3. Pulp mills will have to convert to a processing method that will work with bamboo.

4. The bamboo grower will have to be assured of a market before he can take the risk of investments in planting.

5. Industry must be assured of sufficient bamboo supplies before converting entire plants to bamboo processing.

6. Certain chemical problems, particularly that of excess plant silica which is comon to bamboo and most other grasses, must be dealt with.

Confining Bamboo to a Definite Area. Three methods of confining running type bamboo have worked at Auburn:

1. Cutting off the rhizomes twice each year by running a subsoil plow about 15 inches deep around the bamboo in the spring and again in the fall. On a small scale this may be done by digging a trench around the bamboo and refilling it.

2. Putting a metal barrier around the bamboo. The metal should extend about 2 feet into the soil.

3. Cutting off the new shoots or treating them with a herbicide as soon as they start up in the spring. This must be done every few days for about 6 weeks since all the new shoots do not come up at one time. A herbicide that has worked satisfactorily is a mixture of 9 parts kerosene or diesel oil and 1 part creosote, with

1 or 2 tablespoonsful applied to the top of the shoot as soon as it emerges from the ground. This will kill it back to the mother rhizome.

ERADICATING BAMBOO. Bamboo can be eradicated by several methods:

1. Graze it with cattle during the summer. If the plants are so large that cattle cannot bend them over to graze the leaves, they should be cut and the cattle allowed to graze the new plants as they emerge.

2. Cut the old plants in winter or early spring and the new shoots as they emerge in the spring and summer. This will require cutting several times.

3. Spray the area with a herbicide. Of the several tested at Auburn, Sodium TCA (sodium salt of trichloroacetic acid) gave best success. This should be sprayed on the soil over the area in which the bamboo is growing at a rate of 50 pounds active ingredient in at least 100 gallons of water per acre. It is preferable to apply it in late winter or early spring before new growth starts. Rain will carry the chemical down to the root system and it will be absorbed. This will sterilize the soil for about 90 days, so nothing should be planted on the area until about June.

Caution: TCA is caustic and will burn the eyes and skin. Care must be taken not to get it on animals or persons. It is corrosive to metals and a sprayer must be cleaned immediately after applying.

SUMMARY

Small areas of bamboo are found in nearly all sections of Alabama. The running type bamboo is better suited to Alabama. The clump type is winter hardy only in the immediate Gulf Coast area.

Experiments have been conducted at Auburn since 1933 and at Camden since 1959. The findings are summarized:

1. The most winter hardy species were *Phyllostachys rubromarginata, P. viridis,* and *semi-arundinaria fastuosa.* The next most hardy were *P. aureosulcata, P. nigra var. henon,* followed by *P. bambusoides, P. meyeri,* and *P. aurea.*

2. When all canes were cut, the yield of poles 15 feet or longer varied from 11,000 to 39,000 per acre.

3. When canes were selectively cut, yields were 2,000 to 10,000 per acre per year, depending on species.

4. The yield of large poles from the large-growing species was about 1,000 per acre per year.

5. The yield of dry wood varied from 17 to 54 tons per acre, depending on the species.

6. Bamboo cut in 10-foot strips recovered much faster than when all canes were cut.

7. Cutting in 10-foot strips every 5 years produced a yield of 18 to 45 tons of dry wood per acre. The 4-year average yield was 28 tons per acre.

8. Bamboo plants averaged the following by weight: green leaves, 14 per cent; branches (dry weight), 16 per cent; and dry matter, 63 per cent.

9. Survival rate was 19 to 39 per cent (average 26 per cent) from plants and 0.7 per cent to 86 per cent (average 6 per cent) from rhizomes.

10. *Phyllostachys rubromarginata* had the highest survival rate.

11. Loblolly pine yielded 8 tons of dry wood 8 years after planting. *P. bambusoides* bamboo produced 14 tons in the same period.

12. *Phyllostachys rubromarginata* produced the largest tonnage of dry wood per acre of any of the varieties tested at Auburn and at Camden.

Bamboo could be grown for wood pulp in Alabama. It has several advantages for this use, but a number of problems need to be solved before extensive plantings are made.

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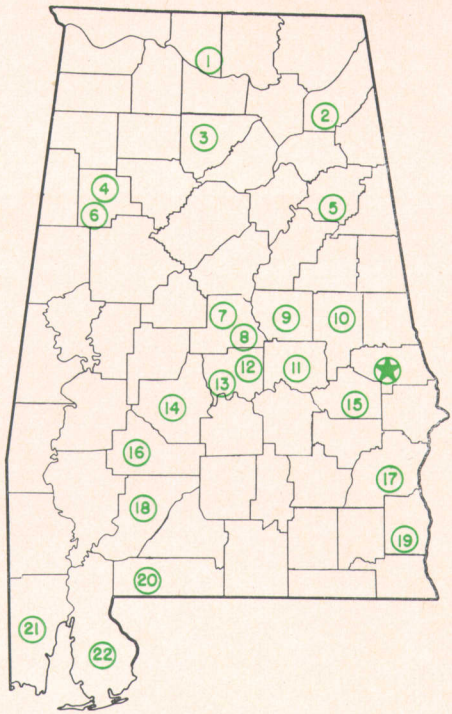
With an agricultural research unit in every major soil area, Auburn University serves the needs of field crop, livestock, forestry, and horticultural producers in each region in Alabama. Every citizen of the State has a stake in this research program, since any advantage from new and more economical ways of producing and handling farm products directly benefits the consuming public.



Research Unit Identification

★ Main Agricultural Experiment Station, Auburn.

1. Tennessee Valley Substation, Belle Mina.
2. Sand Mountain Substation, Crossville.
3. North Alabama Horticulture Substation, Cullman.
4. Upper Coastal Plain Substation, Winfield.
5. Alexandria Experiment Field, Alexandria.
6. Forestry Unit, Fayette County.
7. Thorsby Foundation Seed Stocks Farm, Thorsby.
8. Chilton Area Horticulture Substation, Clanton.
9. Forestry Unit, Coosa County.
10. Piedmont Substation, Camp Hill.
11. Plant Breeding Unit, Tallassee.
12. Forestry Unit, Autauga County.
13. Prattville Experiment Field, Prattville.
14. Black Belt Substation, Marion Junction.
15. Tuskegee Experiment Field, Tuskegee.
16. Lower Coastal Plain Substation, Camden.
17. Forestry Unit, Barbour County.
18. Monroeville Experiment Field, Monroeville.
19. Wiregrass Substation, Headland.
20. Brewton Experiment Field, Brewton.
21. Ornamental Horticulture Field Station, Spring Hill.
22. Gulf Coast Substation, Fairhope.