THE STUART FOREST NURSERY

INTRODUCTION

In August 1933 an old abandoned farm in an open stand of young longleaf pine reproduction about 3 miles west of Pollock, La., was selected as a site for the Catahoula Nursery. The area is on Caddo very fine sandy loam, fairly well drained, with a slight slope to the south and west. A reservoir was constructed nearby on Haw Creek for water supply. Rainfall here is between 50 and 55 inches annually.

Labor, except for building construction, was entirely by CCC boys from a nearby camp. Despite difficulties, handicaps and delays, clearing was begun, and by January 1934 some 14 acres were ready for seedling production. About 16 acres additional were cleared to be put in cover crops in preparation for the 1935 production. In the fall of 1934 about 49 more acres were cleared, making a total potential production area of about 79 acres.

In March 1934, 14 acres were sowed to longleaf, slash, and shortleaf pine. The 1934 production was 8,887,000 seedlings, which were planted on the Kisatchie National Forest, the DeSoto National Forest, and at various places in Alabama, Arkansas, Florida, and Texas.

The seed for this production was extracted at the Nursery from cones shipped by rail from Florida, Georgia, South Carolina, Alabama, Mississippi, Louisiana, and Texas. Some seed came from Arkansas. In the fall of 1934 the nursery received a total of 8,715 bushels of slash pine cones, 25,108 bushels of longleaf pine cones, 200 bushels of shortleaf pine cones and 450 pounds of extracted shortleaf pine seed, and 225 pounds of seed of loblolly pine.

The present permanent Nursery staff (August 1935) is: Nurseryman, A. D. Read; assistant nurseryman, J. T. May; extracting foreman, H. H. Muntz; and 4 or 5 other technical foresters used as foremen as need arises. The experiment station staff of the Nursery consists of M. A. Huberman and A. D. McKellar.

The buildings at the Nursery in 1934 consisted of two offices, nurseryman's residence, water tower and pumphouse, equipment depot, shop, implement shed completed by PWA labor in July 1934, and two curing sheds and extractory completed during the winter of 1933. In 1935 the new extractory and four new curing sheds were built by PWA labor.

<u>NOTE</u>: Nursery practice, as such, begins with the sowing of the seed and ends with the shipping of the planting stock from the nursery. Included in this summary, however, are illustrations of cone and seed handling and of various studies conducted in the nursery.

All photographs are by the author unless otherwise designated. Acknowledgment is due J. D. Nellis and Philip C. Wakeley for photographs for which they are responsible. Thanks are also due A. D. Read, J. T. May, and H. H. Muntz for important figures and data included in the descriptions.

The Stuart Forest Nursery building area in 1934.

The nursery is divided into blocks I, II, and III, which in turn are divided into compartments, about 3.5 acres each, completely surrounded by roads. These in turn are made up of sections. Each section consists of 7 spray lines, each of which waters 10 rows of beds. The beds themselves are 100 feet 8 inches long by 56 inches wide; of this, the sowed area is 100 feet long by 48 inches wide, leaving a 4-inch unsowed shoulder on all sides. The 1934 area consisted of 1,066 beds.

The paths between beds are 10 inches wide, the aisles between sections 28 inches wide, and the roads between compartments 12 feet wide.

The seedbeds in block I in 1934, showing the road, aisle and path system, and the overhead water system.

SEED EXTRACTION

The cones from which the seeds were extracted in 1934 were collected in Florida, Georgia, South Carolina, Alabama, Mississippi, Louisiana, Arkansas, and Texas, and shipped to the nursery in sacks by rail.

1934 Cone Data

Species	Source	Quantity	Costs		
			Collection	Transportation	Total
Slash	Louisiana	320 bu.	$ 260.68	$ 86.25	$ 346.9
	Florida / Georgia	8,325 bu.	8,187.00	3,202.32	11,389.3
	Mississippi	70 bu.	52.60	15.52	68.1
	TOTAL	8,715 bu.	$ 8,500.28	$3,304.09	$11,804.3
Longleaf	Florida / Georgia	10,563 bu.	$ 7,199.31	$4,019.84	$11,219.1
	Mississippi	9,063 bu.	3,160.85	2,141.81	5,302.6
	Alabama	3,600 bu.	1,576.00	1,102.26	2,678.2
	South Carolina CCC collection	1,882 bu.	1,035.00	789.49	1,824.4
	TOTAL	25,108 bu.	$12,971.16	$8,053.40	$21,024.5
Shortleaf	Mississippi	200 bu.	$ 150.00	$ 86.98	$ 236.9
	Arkansas	450 lbs. (seed)	-	-	480.1
	TOTAL	-	-	-	$ 717.1
Loblolly	Georgia	225 lbs. (seed)	-	-	$ 220.5
TOTAL, ALL SPECIES		-	-	-	$33,766.5

The curing sheds are 80 by 18 feet, with corrugated galvanized iron roofs. Eight-inch shutters opposite each of the 6 shelves or bins, and the 2 end doors, provide the necessary ventilation.

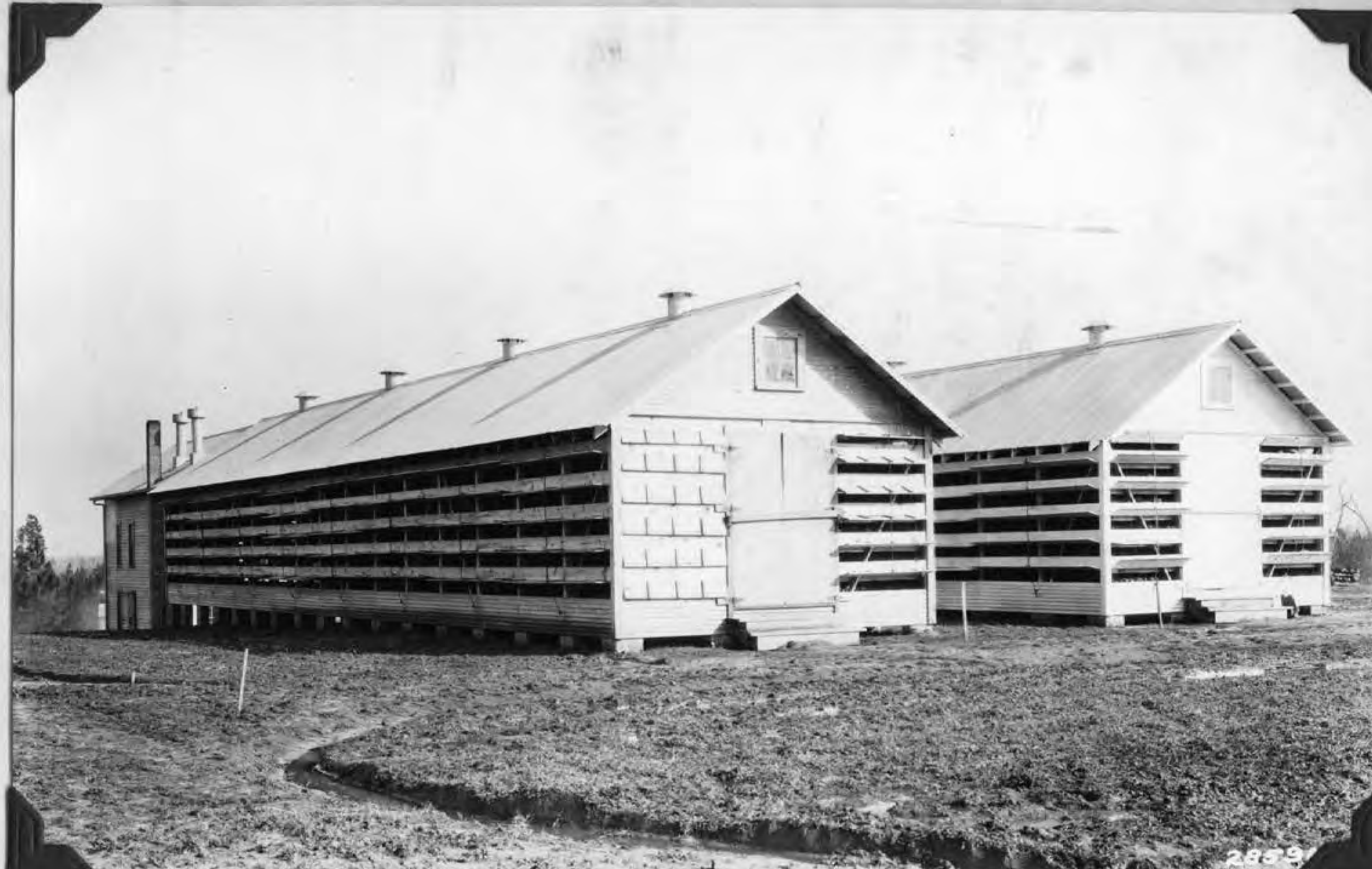


Photo by J.D.Nellis

Curing sheds.

The sheds have a 6-foot aisle with 6 shelves or bins on each side, the full length of the shed. Each shelf is 6 feet deep, 16 inches from top to bottom, and has a hinged door to facilitate filling and emptying the bins. Each shed has a capacity of about 2,000 bushels.

The cones are placed on the shelves in a 6-inch layer. The shutters and doors are opened on dry days and closed on wet days. The cones remain here for 2 to 4 weeks until they have lost a large percentage of their water.

In 1935 boards were placed across the aisle from shelf to shelf and cones placed thereon.

Photo by J.D.Nellis

Interior of curing shed. 1934.

Rarely, cones are air-dried outdoors without being placed in the kiln. The air-drying method, however, requires 4 to 5 days as compared with 10 to 12 hours in the kiln. Besides the factor of time, the space required to handle large quantities of cones by this method would be almost prohibitive.

Air drying of slash pine cones.

When the cones have been precured in the curing sheds, they are loaded into trays. These trays are 5 feet square at the bottom, with a 4-inch flare on the sides, and are 8 inches deep. The ends of the trays do not flare. The trays are made of hardware cloth welded and bolted to an angle-iron frame, with strap iron and rod iron for supports. They were made in Alexandria, La., by a local foundry, at a cost of $5.03 per tray.

In the upper picture, surplus cones, for which there was no room in the curing sheds, are being emptied from sacks into the trays without benefit of precuring. Ordinarily the trays are loaded directly from the shelves. Each tray is placed on a skid and filled. Then an empty tray is placed on the first and filled in turn until there is a tier of 8 trays. Each tray holds 3 bushels of cones, so that each skid carried 24 bushels. The skids are then moved with an industrial lift jack to the receiving room of the extractory.

The skids were made by Kircham-Hall Company of Philadelphia at a cost of $13 each. The lift jack came from Colson Manufacturing Company and cost $40.

Loading cone trays.

Wheeling the loaded cone trays from the curing sheds to the extractory.

The loaded skid is here shown on the tram just before being taken into the receiving room of the extractory.

Photo by J.D.Nellis

Cones ready to go into the extractory.

The extractory[1] is a 2-story building 72 by 24 feet. The floor of the second story is 5 inches lower than the floor of the curing sheds to permit the easy transfer of cones along the connecting tram. The conveyor belt at the rear of the building takes the empty cones to the incinerator, 40 feet from the building.

On the second floor are the receiving room, the kiln or dry room, a discharge room, and the fan room. On the first floor are the machine room, the furnace room, a seed-testing room, and a storeroom.

The cost of the equipment and the building is slightly more than $7,400.

During the 1934-35 season approximately 25,000 bushels of longleaf and 9,000 bushels of slash pine cones passed through the extractory.

1/ Muntz, H. H. The seed extractory at the Stuart Forest Nursery. Planting Quarterly, July 1, 1935.

Photo by J.D.Nellis

The 1935 extractory building.

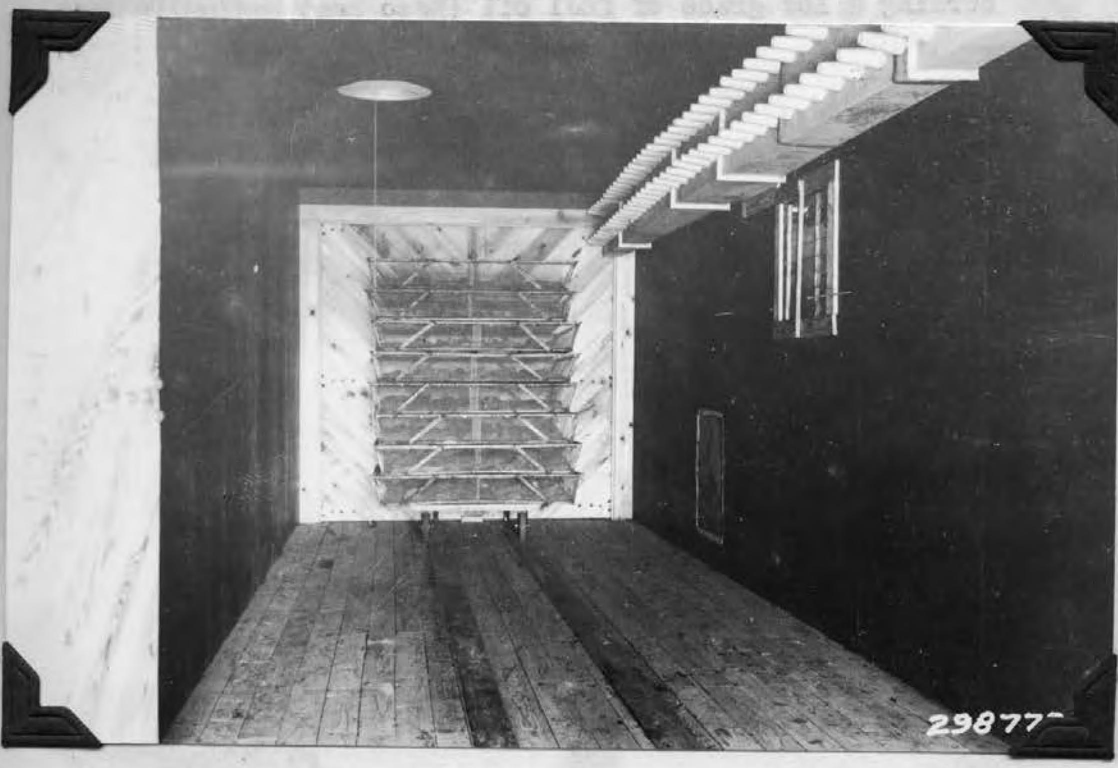
The kiln is 9 by 26 by 9 feet high and is located in the center of the second floor. The walls and ceiling of the kiln are insulated with Masonite and Presdwood. Seen at the upper right is the Carrier ejector nozzle air-circulating unit which forces the hot air, under pressure, into the kiln at the ceiling line. This unit is made up of an air duct which terminates in eighty 1-1/2-inch ejector nozzles, and in the fan room an air heater, fan, and thermostatic control unit. The fan, operated by a 1-horsepower motor, draws the air through heating coils and forces it into the kiln through the air duct. The air circulates in the kiln in a spiral motion, thus reaching all parts of the room. A portion of this warm air is taken through a return air grill in the kiln wall, drawn through the heater coils again with a regulated amount of fresh air,and forced back into the kiln. In the top of the kiln is a 14-inch ventilator, and in the east wall a relief air-damper which takes care of the necessary exhaustion of the humid air. Humidity is controlled by dampers in the exhaust vent and in the fresh-air intake.

A kiln charge consists of a total of 120 bushels of cones in 5 skids of 8 trays each.

In 1935 drying schedules varied from 10 to 12 hours for precured longleaf to 12 to 16 hours for sacked longleaf. Slash pine cones air-dried for 6 to 8 weeks opened in 8 to 10 hours. Optimum drying time was determined by recording yields for different charges at various lengths of time and calculating the yield per hour. These yields were then correlated with costs of cones and kiln operation.

The air in the kiln is maintained at about 125° F. by thermostatic control.

The Carrier system cost $870.



Interior of the kiln or dry room.

The source of heat for the kiln is a General Electric oil-burning, low-pressure steam boiler unit, the furnace burning a low grade of fuel oil (Esso heat medium). Steam is thus supplied to a radiator or air heater. The furnace is automatically controlled. The fuel-oil tank, with 1,000-gallon capacity, is just outside the building, under ground, and through a feed line on the floor supplies the oil from this tank to the surface. Oil consumption is at the rate of 1 gallon of oil per hour, at a cost of 5 to 6-1/2 cents per gallon.

The fire hazard is practically nil in the use of such a unit. The fact that highly inflammable, resinous material is being handled in this extractory makes it absolutely essential that the fire hazard be reduced to a minimum.

The heating unit cost $1,017.30.

Photo by J.D.Nellis

Electric oil-burning, low-pressure steam boiler unit.

In the fan room is the fan which forces heated air through the kiln; the heating coils with the fresh-air intake, relief air-damper duct, thermostatic control, and a recording thermometer. This latter, with a recording psychrometer on the outside of the west wall of the kiln, provides a visible permanent record of temperature and humidity.

The thermostat is attached to a modutrol motor which regulates a snap-action valve in the steam line to control the temperature in the kiln.

The recording thermometer, made by Taylor Instrument Company of Rochester, cost $70.38.

Photo by J.D.Nellis

Fan room for the kiln.

After the cones have been in the kiln the required length of time--10 to 16 hours for longleaf and 8 to 10 hours for slash pine--the skids are wheeled out into the discharge room. Here the trays are emptied into a bin. The cones are then raked through an opening into a chute discharging into a cone-shaker on the first floor. Inasmuch as the next charge is in the receiving room ready to be put in the kiln, it is possible for 2 men to empty and reload the kiln in 10 to 15 minutes. A charge of 120 bushels can be dumped into the bin in 45 minutes. An hour is then required to run this charge through the shaker.

Occasionally the unopened cones must be sorted out before being fed from the bin down into the cone-shaker on the floor below.

The cones fall into the shaker (not shown in this illustration), which consists of a revolving rectangular-shaped frame covered with hardware cloth, smaller at the receiving end than at the discharge end. As the shaker revolves, the open cones are tumbled around and the seed shaken out through the hardware cloth onto the floor, and the empty cones continue out the lower end of the shaker to an endless belt which conveys them to the incinerator.

The seeds are shoveled up and placed in a dewinging machine to remove the wings, then through a commercial fanning mill (Clipper 2B)--similar to that used in cleaning grain--to separate "the wheat from the chaff" and to remove the empty seed. The seeds are then tested for soundness and purity, and stored in galvanized iron cans.

The shaker, dewinger, and fanning mill are operated by belts from a shaft turned by a 3-horsepower motor.

The cone-shaker and continuous dewinger were designed at the nursery.

The costs for the extractory-room equipment are:

Cone shaker	$ 60.00	
Dewinger	125.00	
Fanning mill	45.00	
Motor (3-hp.)	295.00	
Galvanized iron seed cans (216) . . .	291.60	or $1.35 each
Tops for these cans . .	87.50	or 41 cents each

Photo by J.D.Nellis

Dewinger, fanning mill and motor on the first floor of the 1934 extractory.
The 1935 extractory is arranged differently.

The dewinging process is essential to permit the use of a seed drill in sowing slash, shortleaf, loblolly, and especially longleaf. The seed from the shaker is dumped into the hopper of the dewinging machine[1] and is rubbed against a corrugated, perforated surface by rotating bristle-brushes. The slope of the interior of the machine is sufficient to permit the dewinged seed to progress to the lower end and through a chute into a container. A portion of the "chaff" is forced through the perforations into a trough under the machine. In longleaf, the wings are simply reduced to mere stubs, whereas in the other pine species the wings are completely removed.

After this process, and after cleaning in the fanning mill, the seeds are tested for soundness by cutting, and for purity. Samples of the seed are tested at the extractory. Supplementary tests are run at the experiment station.

The cleaned seed is stored in 30-gallon galvanized iron cans with flat tops. These cans hold 80 to 90 pounds of longleaf or 130 to 140 pounds of slash seed.

The extractory crew consists of 4 men, 2 in the machine room extracting seed and 2 on the second floor loading and emptying trays. During the extracting season the plant runs continuously, day and night.

1/ Huberman, M. A. Mechanical advances at the Stuart Forest Nursery. Southern Forest Expt. Sta. Occasional Paper No. 48, 8 pp., illus. August 1, 1935.

The 1935 continuous dewinger.

Interior of dewinger, showing perforated, corrugated surface, and bristle-brushes. Chute at lower end.

SEEDBEDS

In preparing the soil for seedbeds, it is the policy to grow a green-manure crop one year and seedlings the following 2 years--a 2-1 rotation. Consequently, in 1934, 2 crops of whipporwill cowpeas, fertilized, were grown on block II and plowed under. After the second crop had been plowed under, contour terraces were built to prevent soil washing during winter rains.

In February and March 1935 the soil was ready for working up into seedbeds.

Block II just after the cowpea crop had been plowed under in 1934. The 1935 seedbeds were located here.

Preparation

As soon as the soil has dried out sufficiently to permit working, in February and March, it is plowed and disced several times, with the aid of a caterpillar tractor.

The next step is to pulverize the soil to a depth of 8 inches, by the use of a rototiller. The rototiller accomplishes this by means of curved hooks attached to a rapidly revolving shaft, driven by a gasoline engine.

The equipment used consists of:

1 Cletrac tractor, at a cost of	$1,445.00
1 disc harrow	205.00
1 gang plow	84.55
2 rototillers, each purchased from Rototiller, Inc., 21-24 44th Avenue, Long Island City, N.Y.	680.00,

Photo by J.D.Nellis

Using a rototiller to pulverize the soil.

After the soil has been pulverized, the necessary stakes are set at specified distances from creosoted posts set permanently 6 inches below the plow line, in the north and south aisles. These aisles are 28 inches wide and divide the compartments into sections. When the stakes marking the beds are set, a mule with a 14-inch middle buster plows out the paths. Strings are then set and the beds are ready to be worked. In 1935 the rototiller was used after the beds had been lined out. Following the rototiller, men with potatohooks go over the beds, removing roots and debris and thoroughly working up the soil, and roughly smoothing off the beds. Men with rakes follow, to complete the job of pulverizing and leveling the beds, being sure to make the bed 56 inches wide. The paths are then shoveled out and debris picked up. The beds are ready for sowing.

A crew[1/] consisting of 2 lining-out men, 1 clean-up man, 4 alley men, 12 hookmen or roughers, and 6 rakemen or finishers requires the following time for the various operations:

Operation	Beds per man-hour	Man-hours per bed
Plowing alleys	30.80	0.032
Cultivating	22.00	0.045
Lining out	2.50	0.40
Roughing (potatohooks)	0.42	2.38
Finishing (rakes)	0.84	1.19
Shoveling paths	1.90	0.53

1/ Read, A. D. Work Plan, Stuart Forest Nursery. Typewritten, 50 pp. July 12, 1935.

Working up
beds with
potatohooks
and rakes.

Photo by
J.D.Hollis

Sowing

Although all of the slash, shortleaf, and loblolly, and most of the longleaf seed, is drill sowed, broadcast sowing by hand is also used.

In broadcast sowing, a bed-marker is placed on the bed as a guide. This marker consists of 2 pieces of 2-by-4, 58 inches long, with 3 pins inserted in each piece--1 pin in the middle and the outside pins 2 feet away. These 3 sets of pins are connected by strings 100 feet in length. At 25-foot intervals along the strings washers are tied to divide the bed into 8 equal portions measuring 2 feet by 25 feet.

Roughly speaking, the rate of sowing will be such as to insure a stand of 25 to 30 plantable longleaf per square foot and 35 to 40 slash, shortleaf, and loblolly per square foot. On the basis of past experience, this means approximately 8 to 10 pounds of longleaf, 2-1/2 pounds of slash, 12 ounces of shortleaf, or 2 pounds of loblolly per 100-foot bed.

The seed for a given bed is weighed out into 8 equal portions and brought to the beds in paper sacks. The sowers, 4 to a bed, scatter the seed uniformly between the strings and washers, going over each portion of bed twice--lightly the first time, leaving about one third of the seed in the bag, and using this seed on the second trip to insure an even distribution. The marker is then moved to the next bed.

Broadcast sowing requires 0.58 man-hour per bed, or 1.74 beds per man-hour.

Photo by J.D.Nellis

Broadcast-sowing longleaf by hand.

When the beds have been sowed, a 400-pound wooden roller is used to bring the seed into intimate contact with the soil.

This roller was made locally at a cost of $25.

Photo by J.D.Nellis

Rolling hand-sown broadcast longleaf beds.

Because drill sowing is faster than broadcast sowing, and because weeding and lifting are easier in drills, the Williamson longleaf drill seeder was developed at the Stuart Forest Nursery.[1] Slash, shortleaf, and loblolly are all drill sowed with a Hazard drill seeder, of which the Williamson seeder is a modification to accommodate longleaf.

Seven men are required to operate a drill seeder; 4 pull the machine, 2 push it, 1 operates the gearshift and watches the seed flow, and 1 puts the boards in place across the ends of the beds to permit continuous passage of the machine. A crew with seeder can sow about 160 beds per 6-hour day.

The use of a straddle-bed tractor similar to that used at the Saratoga Nursery in New York is being considered.

The 2 Hazard seeders were purchased from the Kirby-Williams Iron Works of Jackson, Tenn., at a cost of $238 and $305, respectively.

1/ Huberman, M. A. Mechanical advances at the Stuart Forest Nursery. Southern Forest Expt. Sta. Occasional Paper No. 48, 8 pp., illus. August 1, 1935.

Williamson longleaf drill seeder, developed at the Stuart Nursery as a modification of the Hazard drill seeder.

A worm feed carries the seed from the hopper into the 8 seed tubes which are spaced 6 inches apart. The gears which revolve the 8 worms are turned by a chain and sprocket geared to the large roller.

This modification replaces the seedbox and feed on the original Hazard seeder. The remainder of the machine is the same as the Hazard.

Interior view of seedbox of
the Williamson longleaf drill seeder.

The drill seeder has the further advantage of rolling the seed into the soil after sowing, all in one operation.

For best results with longleaf, the seed should be as free as possible of wings and of impurities such as cone scales.

Bed sowed by Williamson longleaf drill seeder, developed at the Stuart Nursery.

The seeds must be protected from disturbance by wind and rain; the soil must not be allowed to dry out; and birds must be guarded against. This is accomplished by placing burlap sheets on the sowed beds, and holding the sheets in place with wire pins at intervals of 3 to 4 feet on both edges of the bed.

Old burlap bags sewed together were used in 1934, but new burlap in rolled sheets is much better and, although more expensive, can be used for more seasons. Old burlap costs 7 cents per yard and new burlap 8-1/2 cents.

Photo by J.D.Nellis

Laying burlap on sowed beds.

Rolling the burlap on spools and placing on wheels was tried out in 1935 to facilitate the laying of the burlap on the beds.

As 2 men move the wheels along the bed, the end of the burlap is fastened in place by pins by 4 men, who continue to pin the burlap at intervals of 3 to 4 feet.

This arrangement is a local modification of a system of laying burlap used in other southern nurseries. The machine is made from a hose reel, and because it is still being improved its use is in an experimental stage.

Laying burlap requires 0.55 man-hour per bed, or 1.8 beds per man-hour.

In 1935, 68,000 yards of burlap were used on 3,789 beds.

Putting burlap in place and pinning it down.

After the burlap has been in place for a period of 8 to 22 days, the seed begins to germinate. When most of the seed have germinated the burlap should be removed. If it is left in place too long, slash, shortleaf, and loblolly push through it and are broken off when it is lifted; longleaf flattens out along the ground, and may become etiolated (lacking in green color) and weakened.

Shortleaf seedlings growing through the burlap.

Pine needles or "straw" may be used as a mulch instead of burlap. There is little to choose between the two as to the effect on the seedlings. The choice will be determined largely by availability of needles and labor.

Sand or nursery soil has been effectively used experimentally as a seed cover. The cost of putting this cover in place is higher but there is a saving in cost of removal, because the sand or soil need not be removed. This cover should not be more than 1/8-inch in depth, however. The danger of damage by heavy washing rains during the germination period makes burlap much to be preferred.

Removal of burlap or straw requires about 0.33 man-hour per bed, or 3 beds per man-hour.

Removing burlap from seedbeds.

Removing pine-needle mulch from seedbeds.

Growing Season

The longleaf seedlings, 30 days old, have just shed their seedcoats, and the cotyledons are opening out into rosettes. The roots at this age are approximately 4 inches long. At this time the density of the seedlings is about 40 to 45 per square foot.

Broadcast-sowed longleaf about 30 days after sowing. May 3, 1934.

At 30 days of age slash pine have shed the seedcoats and the primary needles have begun to appear between the cotyledons. The roots at this age are about 10 centimeters long. The seedlings are here growing at a density of about 25 to 30 per linear foot of drill, or 50 to 60 per square foot.

Drill-sowed slash pine
about 30 days old. May 3, 1934.

Watering

Because seedlings in a nursery are grown under intensive garden conditions, close together, natural rains are usually insufficient in quantity and distribution to meet the needs of the seedlings.

An overhead Skinner watering system costing about $350 per acre is used at the Stuart Nursery for the purpose of furnishing the additional moisture. Roughly speaking, southern pine seedlings seem to do well on about 1 inch of rain a week through the hottest part of the growing season--June, July, and August. In September watering is diminished in order to harden the seedlings, and is usually complete by October 1.

The watering system consists of an underground 6-inch water main with risers at intervals of 56 feet. Each riser feeds a spray line through an oscillator watermotor. When the water is turned on, this motor turns the line through an arc of 180 degrees. Small pinhole nozzles at short regular intervals put out a very fine spray, uniformly distributing the water on 5 rows of beds on each side of the line. A line in operation for 8 hours puts down the equivalent of 1 inch of rainfall.

Watering is done with 7 oscillators at a time for about 5 hours. By watering continuously, this requires about 70 hours to cover the entire seedbed area. This is done between 5 p.m. and 9 a.m. because of high evaporation during the day.

Photo by J.D.Nellis

Skinner overhead sprinkling system.

The water for this system comes from the Stuart Nursery reservoir, with a capacity of 12 million gallons, which is about a mile from the seedbeds. A dam and spillway were constructed across a small drainage, Haw Creek, to store water for the nursery. A pumphouse, seen at the right, pumps the water by means of a 6-cylinder Hercules engine and Gould centrifugal pump from an intake near the center of the reservoir through a 6-inch bell-and-spigot cast-iron water main to the water tank and through the 6-inch underground water lines, risers and spray lines. The pressure at the take-off of line number 1 is 125 pounds.

During the 1934 season the reservoir supplied more than 8 million gallons of water, pumped at the rate of 250 gallons per minute. The total watering was equivalent to more than 21 inches of rainfall exclusive of natural rains that fell during the growing season.

An auxiliary pumping station about 800 feet below the dam is used to pump water into the reservoir at the rate of 80 to 100 gallons per minute. This helps to maintain the supply in the reservoir.

Photo by Philip C. Wakeley

Panoramic view of Stuart Nursery reservoir.

Weeding

As in all gardening, it is not long before weeds begin to appear. Weeding by hand is a tedious, tiresome job, but a very essential one. About 25 to 30 days after the burlap has been removed weeding should begin. It is easier to get ahead of the weeds by pulling them while they are small than when they are larger. In 1934 all beds had to be weeded at least 5 times, and some of them more than 5, at intervals of about 1 month. Longleaf beds required 4,614 man-days, slash 1,655, and shortleaf 1,828 man-days. At a cost of $1.20 per man-day, this totaled $9,716.40, the biggest single item in final cost figures.

Fortunately, the number of weeds is greatly reduced the second season, and will undoubtedly become less in ensuing seasons. In 1935 weeds were not nearly so serious or so abundant as in 1934.

The most common weeds in the nursery are the panicum grasse *Panicum angustifolium* and *P. lanuginosum*; various sedges; *Scirpus carinatus*; *Paspalum plicatulum*; *Paspalum dilatatum*; *Cyperus rotund* or coco-grass (which is rare here); *Fimbristylis geminata*; *Rynchos compressa*; broomsedge, *Andropogon virginicus*; Bermuda grass, *Cynod dactylon*; crabgrass, *Eleusine indica*; carpet grass, *Axonopus compr* bent grass, *Agrostis hiemalis*; and foxtail grass, *Chaetochloa lute* Among the more common broad-leaved weeds or phorbs are poor-joe, *Diodella teres*; chickweed, *Alsine fontinalis*; sensitive-pea, *Chamaecrista littoralis*; spurge, *Chamaesyce strictospora*; *Polypremum procumbens*; *Oldenlandia Boscii*; plantains, *Plantago virginica* and *P. heterophylla*; bitterweeds; and everlastings.

Weeding Longleaf beds in 1934

~~Weeding longleaf beds, in 1934.~~

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Weeding Shortleaf beds in 1935.
Note how much cleaner the
Nursery is, and how relatively
few boys are required.

The tiresome job of weeding is made easier by the use of benches, and of small metal "spuds" to relieve the fingers.

In drill-sowed beds narrow triangular hoes are used to get the weeds between drills, but the weeds among the seedlings must be pulled by hand.

Paths and bed-shoulders are weeded with the aid of broad garden hoes.

Weeding seedbeds with the aid of benches, in 1934.

Hoeing weeds in the paths and on the bed-shoulders.

Shading

Southern pines as a rule have been grown without shades. At the end of June 1934, when the water supply threatened to run low, one-half shade lath was used to conserve soil moisture on a few beds of longleaf and of shortleaf.

The laths were stapled to wire, exactly 1 lath-width apart, in 25-foot lengths, thus giving one-half shade. These lengths can be put up in convenient rolls easy to handle.

In putting the shades in place, 2-by-4 upright stakes, sharpened at the lower end, were driven into the ground and 1-by-4's nailed on them, on each side of the bed. The lath shade was then rolled out on this supporting framework.

Constructing lath shades.

Putting shade supports in place.

The beneficial results of the use of this shade in 1934 were not outstanding enough to warrant the general continuance of the practice.

Experiments are under way at the Stuart Nursery to confirm the 1934 results.

Photo by J.D.Nellis

Lath shade in place on shortleaf beds.

At the age of 4 months, longleaf has well-developed fascicled or secondary needles about 4 to 6 inches in length. The roots are about 8 to 12 inches long, with some laterals and mycorrhizae developed. The trees are growing here at a density of about 25 to 30 per square foot.

Photo by J.D.Nellis

Longleaf pine about 4 months old. August 1934.

When slash pine is 4 months old the secondary or fascicled needles appear, bark forms on the stem, and the diameter of the stem begins to increase. The tops are about 6 inches high, the primary root is about 8 inches long, and the lateral roots are developing. The seedlings here are growing at a density of about 30 per linear foot of drill, or about 60 per square foot.

Photo by J.D.Nellis

Slash pine about 4 months old. August 1934.

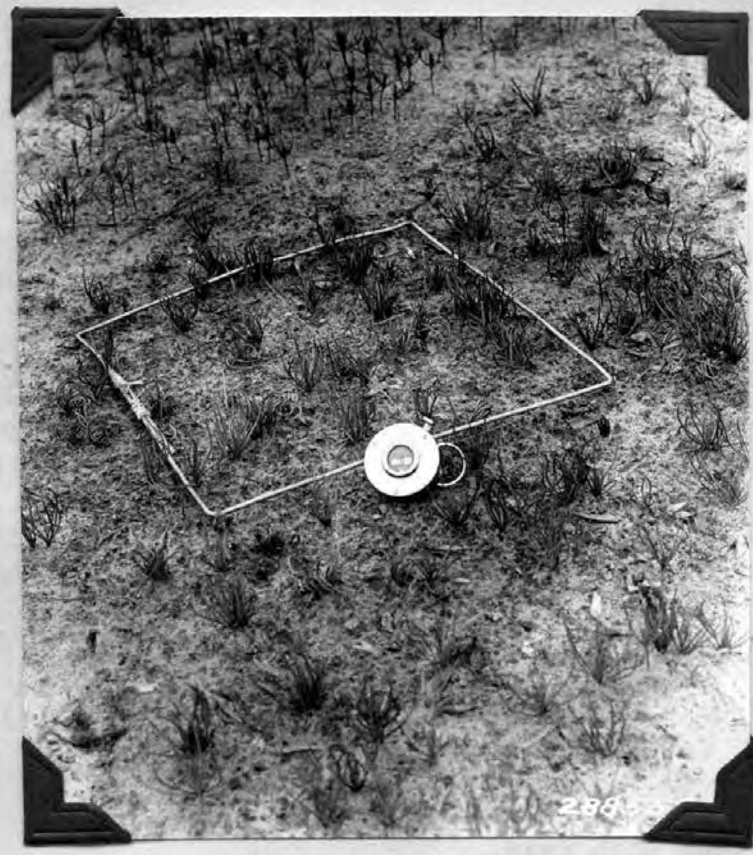
Inventory

In order to find out how many trees will be on hand at time of lifting, it is the general practice to take inventory the end of June and again at the end of September. In the last inventory plantable and cull are counted separately; in the first, only a total count is made.

A method of sampling the nursery was worked out which permitted a fair estimate of the number of trees on hand.[1] A foot-square wire templet, divided into 4 quadrants by picture-wire, was placed on the beds at mechanically located intervals--on the first bed, 10 feet from the end and 1 foot from the edge; the second bed, 20 feet from the end and 2 feet from the edge; the third bed, 30 feet from the end and 3 feet from the edge; the fourth bed, 40 feet from the end and 1 foot from the edge, and so on. This is used where there are different species or different seedlots within a compartment. Where the compartment contains but one species and seedlot, one fourth the number of counts is made, by just making 1 count for each row of 4 beds. The templet in this case is placed at equal distances from the edges of the bed, but at 10, 20, 30, and 40 feet from the ends of the beds, as above.

In 1935, 17 man-days were set up for the summer inventory and 20 man-days for the fall inventory.

1/ Huberman, M. A., and May, J. T. Sampling the forest nursery. Jour. Forestry 32: 1017-1019, illus. (December 1934.) [Briefer articles and notes.]



Method of counting seedlings in taking inventory, using wire templet and tally-register.

~~Method of counting seedlings in taking inventory, using wire templet and tally-register.~~

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Using rectangular templet in 1935 inventory on shortleaf.

Nursery Pests

Brown-spot needle blight, Septoria acicola (Thum.) Sacc., occurred on longleaf and slash pine in the nursery in 1934 and 1935. To combat this, the seedlings were sprayed twice (June 25 to July 20 and August 10 to September 1) with bordeaux mixture (4-4-50), 4 parts copper sulphate and 4 parts hydrated lime to 50 parts water. The spray is made up by dissolving 2 pounds of copper sulphate in 10 gallons of water, dissolving 2 pounds of slaked lime in another 10 gallons of water, and dissolving 1 pound of fish-oil soap in 5 gallons of water. The 3 mixtures are poured into a 50-gallon mixing barrel and thoroughly stirred until a uniform emulsion is obtained. The spray barrel is then filled, and is kept agitated during the entire process of spraying. By means of a pressure pump, this is then sprayed on the seedlings from the spray wagon. The wagon straddles a bed, and 5 rows of beds are sprayed each trip.

A Myers spray pump was mounted on a buggy with a barrel to make an effective spraying apparatus. The pump cost $36.50, the buggy $48.00, and the barrel $2.00, or a total of $86.50.

About 75 to 100 man-days are required to spray 1,400 beds each time.

At a cost of 2 cents per pound for lime, 7 cents for copper sulphate, and 14 cents for fish-oil soap, each spraying (2,720 gallons of spray emulsion) cost $34.78 for materials.

Filling spray barrel with bordeaux mixture.

Spraying bordeaux mixture on longleaf seedlings for brown-spot needle disease.

Smothering disease (Telephora sp.) was common in 1934 but was not very abundant in 1935. The smothering disease is not known to be harmful. It has occurred freely, even where there were no seedlings; and when it does occur on a seedling it has not been found entering the live tissue.

Other diseases which have occurred at the nursery, although not to any important extent, are early damping-off and late top damping-off.

Insect pests, which have been of little importance, include white grubs, tipmoths, and larvae of wood-borer beetles.

The nursery on the whole has been very fortunate in regard to seedling losses from insects and diseases.

Smothering disease on slash
and shortleaf pine (harmless).

LIFTING

Lifting

After the first hard freeze, or after 2 or more frosts, usually about the first week in December, and when growth has presumably stopped, the seedlings are ready to be lifted. This is done by drawing a heavy blade, attached to a steel-rail frame, under the seedbed to sever the root system and partially raise the seedlings so they can be pulled up readily, without injury. The blade is drawn by a cable and winch on a crawler-type tractor.

The 1935 schedule calls for 10,000 man-days to lift, sort, and ship 50 million trees between the first of December and the middle of February.

Photo by J.D.Nellis

Lifting slash pine at the end of the growing season.

The lifter is drawn through the bed, with the blade set for a uniform depth of 11 inches. In order to maintain this uniformity, in 1934, 4 men had to "ride the rods" on the lifter as it was drawn through the beds.

A different design of lifter for 1935 makes the lifting process simpler and more satisfactory. The use of a straddle-bed tractor such as is used in the Saratoga Nursery in New York is being considered.

A closer view of the tree lifter
just after it has been drawn through
a bed of longleaf

A closer view of the tree lifter
just after it has been drawn through a
bed of longleaf.

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The 1935 design lifter. Note
the eccentric axle.

The 1934 lifter, designed by the Region 7 office and built locally at a cost of $75, consisted of the steel-rail frame arranged like a sled runner; to this was bolted a heavy 6-inch blade, which rode at a depth of 11 inches below the surface; the blade was braced by a sloping 2-inch bar on each side, bolted to the rail frame; across the rear ends of the rails was bolted a crossbar high enough to clear the seedlings. The whole was drawn by a chain fastened to the front ends of the rails.

A view of the lifter showing the blade and bracing; placed on a truck for transporting to another part of the nursery.

After the mechanical lifter has been drawn through the bed, the seedlings are further loosened with a spading fork (a shovel was used in 1934), the dirt shaken off the roots, and the seedlings placed in a pile preparatory to being taken to the grading tables.

Care is exercised in lifting to prevent breaking, tearing, or bruising the roots. This is prevented by keeping a trench dug out in front of the seedlings to make loosening the roots easier. The men are also careful to prevent the roots from drying out by keeping them covered with soil or, on the grading tables, with wet burlap.

Lifting longleaf pine with a shovel (spading forks used in 1935). Lifted seedlings have the dirt shaken off and are placed in a pile before being taken to the grading table.

Note the depth to which the shovel (or spading fork) is put before lifting or loosening the seedlings. The object is to get under the seedlings to prevent injury to the roots.

Lifting longleaf with a shovel,
after the blade has been under the bed.

Slash pine can be handled more easily than longleaf because the stem provides more to take hold of in lifting. Drill-sowed seedlings are also more easily lifted than broadcast seedlings. In general, 3 to 5 men--a grading-table crew--can handle two 100-foot beds in a 6-hour day.

Photo by J.D.Mellis

Lifting slash pine, placing them in piles, ready to be taken to the grading table seen at the left.

When the seedlings have been lifted from the bed and the dirt shaken from the roots, an armful is taken by the graders to the grading table. Here the seedlings are kept covered with moist burlap. Two men at each table separate the culls, count the plantable seedlings into bundles of 50 for longleaf or 100 for slash and shortleaf, tie the bundles with string, and put them into a tub of water. In 1935 counting was dispensed with. The number of seedlings shipped was determined by sampling counts.

The tables consist of 4 uprights, a flat table-top, and a top framework bolted together. Canvas is placed around 3 sides and on the sloping top to protect the seedlings and the men from the wind. The tables are of the "knock-down" type, so they can be readily stored when not in use.

Grading in 1935 was done on the ground without the use of tables.

Grading table where seedlings are graded, counted, and bundled.

Seedlings are culled if they give little promise of surviving when planted in the field. A longleaf seedling is culled if the root is less than 7 inches long, if the root-crown diameter is less than 1/8-inch, if the needles are not in fascicles or are very short and scanty, if the terminal bud, or "pincushion" bud, is absent, or if the root is badly injured. A slash seedling is culled if the stem is weak and succulent, if the root is less than 7 inches long, if the lateral roots are poorly developed, if there are no fascicled needles or terminal bud, or if the stem or root is badly injured.

Shortleaf is culled if the stem is weak and succulent, if no needles are in fascicles, or if there is no terminal bud.

Although in 1934 the percentage of culled seedlings ranged from 15 to 40, it is hoped that this will be reduced to less than 10 percent in 1935.

Pile of cull longleaf seedlings.

When the seedlings have been tied in bundles, the roots are pruned with a sharp pocketknife to a length of 7 inches. The bundles are then heeled-in in a trench with the slope to the south (to protect the root-collars from the sun) and the roots covered with moist soil, just to the root-collar. The man doing the heeling-in makes the rounds of the grading tables, and when there is a tubful of bundles he proceeds to prune the roots and heel-in the bundles.

In 1935 a hatchet and marked chopping block were used to prune the roots to the desired length.

Pruning the roots of longleaf seedlings in bundles to a length of 7 inches, with a sharp pocketknife. The bundles are then heeled-in in the trench at the lower right. 1934.

In heeling-in the bundles, care must be taken to use moist soil (during December, January, and February the soil is quite moist from rains), and to tramp it firmly around the roots to prevent drying out. In fact, the exposure of the roots during the entire lifting process must be kept to an absolute minimum. Studies to determine the maximum tolerable exposure to sun and wind revealed the fact that field survival is greatly reduced by exposure of the roots for more than 3 minutes under the most severe conditions of bright sun and drying wind.

Heel-in trench, showing the sloping face and heeled-in longleaf bundles.

To take care of planting needs, a large supply of bundled stock must be kept ready, for trucking to the planting areas in Texas, Mississippi, and Louisiana. To keep planting stock ahead, heeling-in is necessary, sometimes for periods of 1 to 4 weeks. Stock to be sent out of the State, by truck or rail, must be baled to prevent drying out in transit.

In 1934 the following stock was sent from the nursery:

Place	Longleaf	Slash	Shortleaf
LOUISIANA: Kisatchie N.F.	2,704,000	1,840,000	
La.State Univ.	3,000*	3,000*	
Sou.For.Expt.Sta.	207,000	225,000	
MISSISSIPPI: DeSoto N.F.	1,170,000*	1,572,000*	1,488,000*
TEXAS: Sam Houston N.F.	5,000*	5,000*	
FLORIDA: Choctawhatchee N.F.	5,000*	10,000*	
Tennessee Valley Authority			1,000*
	4,094,000	3,655,000	1,489,000

* Shipped in bales.

Longleaf seedlings heeled-in, ready to be baled or taken to the planting site.

Baling

Seedlings to be shipped to the Sam Houston National Forest in Texas or to the DeSoto National Forest in Mississippi by truck, or elsewhere than the Kisatchie National Forest, must be protected against drying out. This is accomplished by baling the seedlings in damp sphagnum moss and waterproof burlap paper.

The bales are about 36 inches long by about 12 inches through, weigh about 35 to 40 pounds, and contain 1,000 longleaf seedlings, or 2,500 slash, shortleaf, or loblolly seedlings, per bale.

The first step in baling is to place on the table 2 pieces of baling wire with the eye-loops hooked on the nails on the backboard, with a wooden slat, 1/2- by 1-1/2 by 24 inches, on the wire, hooking a 5-foot length of burlap paper (24 inches wide) through the 2 nails, with the paper side up. A 1-inch layer of damp sphagnum moss is placed on the burlap.

First step in baling trees.

The next step is to place a layer of seedlings (500 longleaf or 1,000 of the other species) on the moss in two rows, with the root-ends of one row just touching the root-collars of the other, and the bundles alternating to obtain a flat layer. This layer is then covered with an inch of damp moss; care must be taken to see that there is moss between the roots and the burlap at all points. The needles will extend beyond the edges of the burlap.

Second step in baling trees (longleaf).

More trees and more moss are added in layers until there are 1,000 or 2,500 seedlings as mentioned before in the bale, with a final layer of moss on top of the last layer of trees. The ends of the burlap are then brought together, wrapped around a slat, and the burlap tightened by twisting the slat.

Third step in baling trees (longleaf).

When the burlap has been tightened, the slat is held in place with one hand and the wire ends threaded through the eye-loops and pulled taut.

When wires without eyes are used, a Gerrard wire-tyer is employed to effectively twist wires tight.

Fourth step in baling trees (longleaf).

The bale is completed by twisting the wires tight and cutting off the long ends.

The wires are so spaced as to hold the root-collars in place. The roots are completely protected by the wet moss, and the waterproof burlap prevents drying out.

This bale will then stand up under rough handling. In 1934 such bales were shipped by freight from the Stuart Nursery to Greenville, Ala., a distance of about 400 miles, and arrived in good condition. About 4 million trees were safely shipped in such bales by truck to planting sites on the DeSoto National Forest in Mississippi, a distance of 250 miles and an interval of 2 days.

Depending on the handling, the seedlings can be left in the bales from 5 to 7 days without any harmful results.

Final step in baling trees.

The bales are piled up preparatory to shipping by truck. If there is an interval of 2 or more days between baling and loading on trucks, the bales are covered with tarpaulins to reduce exposure to the sun and wind to a minimum.

Baled longleaf piled up, ready for shipment.

SOIL FERTILITY

Because the seedlings are grown close together, and because when they are lifted very little of the plant is left in the ground, it is necessary to take measures to prevent soil impoverishment. To meet this situation the nursery is operated on a 2-1 rotation, in which seedlings are grown on a given block for 2 years and the third year a green-manure crop, which is plowed under to add organic matter to the soil.

In 1934 block II was fertilized with a 6-10-7[1/] commercial fertilizer at the average rate of 200 pounds to the acre, and sowed to whipporwill cowpeas at the rate of 1 to 2 bushels to the acre. Some of the peas were sowed in drills and some broadcast. A grain drill is being used in 1935 to apply fertilizer and sow the peas in one operation.

1/ This 6-10-7 means that the mixed fertilizer contains such an amount of total nitrogen as is equivalent to 6 percent nitrogen; such an amount of available phosphorus as is equivalent to 10 percent phosphoric acid; and such an amount of water-soluble potassium as is equivalent to 7 percent potash, by weight.

Cowpeas as a green-manure crop.

In addition to cowpeas, Sesbania, Crotalaria, velvetbeans, and soybeans, each in pure stands, have been tried at the nursery.

In 1935, 40 man-days were set up for the spring sowing of the 25 acres to peas and beans, the latter part of April. An equal number of days was set up for the fall sowing, or second crop of peas, the first of August.

The costs of the seeds are as follows:

Whipporwill cowpeas	$3.00 per bushel
Speckled velvetbeans	4.00 per bushel
Mammoth yellow soybeans	2.75 per bushel
Crotalaria	2.00 per 10 pounds
Sesbania	2.00 per 10 pounds.

These are 1935 prices from Reuter Seed Co., Inc., New Orleans, La.

Applying commercial fertilizer just before sowing the cowpea green-manure crop.

Broadcast-sowing Sesbania green-manure crop.

Before sowing the peas, the soil must be prepared by plowing, discing, and harrowing, several times. As soon as the peas are sowed, they are disced and cultipacked into the soil. The first crop in 1935 was sowed April 20 to April 27 and the second crop August 15 to August 20.

Just before the crop matures, while it is in the "soft-dough stage," it is plowed under so that decomposition and nitrification can take place. This was June 25 to July 2 in 1935 for the spring crop and October 15 to October 22 for the fall crop. This required 8 man-days each time.

With a fairly heavy soil such as the Caddo very fine sandy loam, which we have here, there is little danger of loss of nutrients by leaching during the winter.

The benefits of the green-manure crop are threefold:

1. Addition of humus.
2. Improvement of the physical condition of the soil.
3. Nitrogen is taken from the air and added to the soil by the nitrifying bacteria on the roots of the legumes.

Covering cowpeas with disc and cultipacker after sowing.

Plowing under cowpeas.

RESEARCH

In the spring of 1934, at the Stuart Forest Nursery, the Southern Forest Experiment Station began studies of tree percent, and cultural treatments, with a view to improving the quality of planting stock.

Plots were established to study germination and early loss of seedlings as affected by seedbed preparation,kinds and time of removal of mulch and cover, pretreatment of seed, watering, and time of sowing; the effect of shading, density, and root pruning on the percentage of high-grade seedling production; the life history or normal development of seedlings; the effect of chemical weeding; soil analysis; and fertilizer practice and soil maintenance.

The office-laboratory shown here, erected in 1934, is 15 by 22 feet; it contains one room 15 feet by 13 feet 8 inches, one room 8 feet 6 inches by 9 feet 10 inches, and a lavatory 8 feet 6 inches by 4 feet 9 inches. The cost was about $1,200.

The office-laboratory of the Southern
Forest Experiment Station at the Stuart Nursery.

All studies except fertilizer studies were carried out on 4- by 4-foot plots replicated 4 times and randomized in 4 blocks for each study. The fertilizer studies were divided into 3 parts: the N-P-K study plots on 5-foot plots in duplicate, randomized in 2 blocks; the rotation study in 20-foot plots, replicated 5 times and randomized in 5 blocks for longleaf and 5 for slash; and the green-manure study in 5-foot plots replicated 5 times and randomized in 5 blocks.

Experimental beds, 1934; fifteen 50-foot beds and four 100-foot beds in block I.

Experimental beds, 1935; forty 100-foot beds in block II. In the foreground are the chemical weed-control studies.

Tree Percentage

In order to ascertain the treatment or group of treatments that will give the highest tree percentage, studies were undertaken to learn the effects of variations in mulch, date of sowing, seed pretreatment, and watering during germination on longleaf, slash, and shortleaf. Each treatment was tried on 4- by 4-foot plots replicated 4 times.

In the tree-percentage studies it was found advisable to mark out a 2-foot strip on the plots with string and sow exactly 100 seeds between the strings. As it germinated, each seedling was marked with a toothpick so a record could be kept, for each of the 5 drills on each plot, of germination and of death of seedlings, by causes. Reexaminations and counts were made at 5-day intervals through the germinating period and long enough thereafter to be sure of no additional death.

The 1934 studies showed favorable results from pretreating the seed--that is, soaking the seed enough to swell it, just prior to sowing; slight but not outstanding differences in favor of a sand or soil cover instead of burlap or straw, when no heavy rains occur during the germination period; and favorable results from watering during the germination period, if rain does not occur frequently enough.

Examination of germinating seedlings
for records of new germination and of death
from various causes.

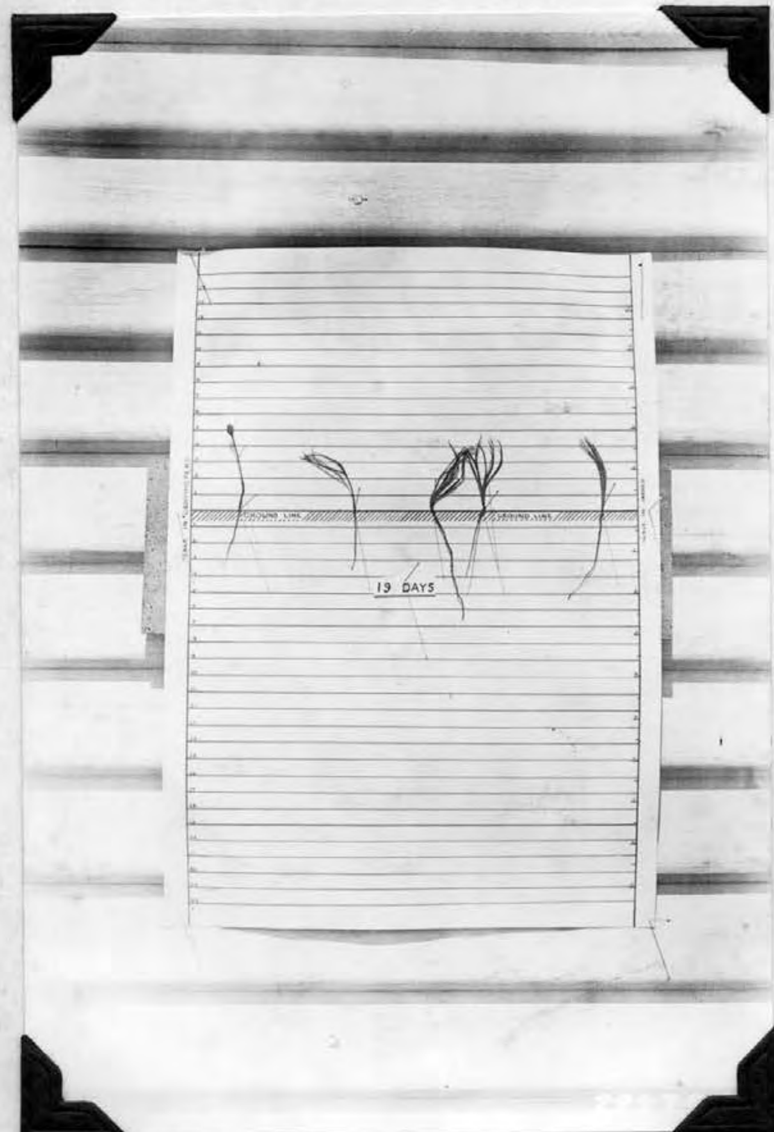
Life History

The life-history studies of slash and longleaf revealed definite periodicity of growth of roots, top height, and stem diameter. Information on the normal behavior of seedlings is essential to explain the behavior of seedlings under various treatments by serving as a basis of comparison.

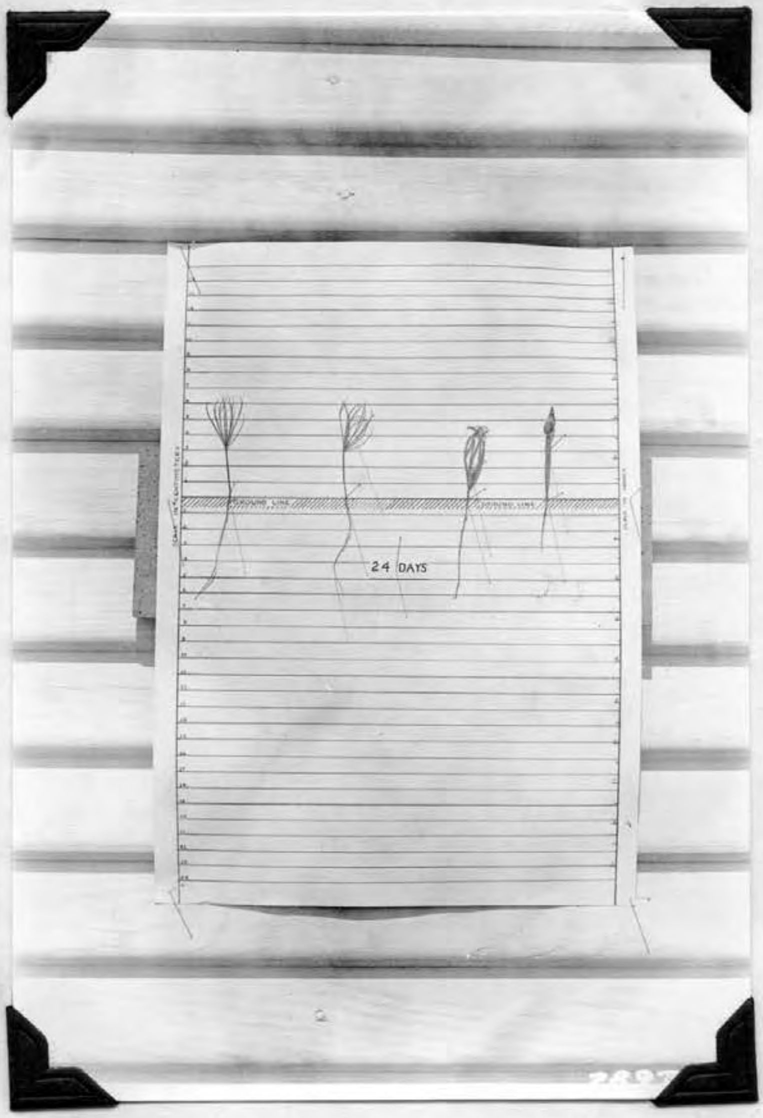
Life-history data, 1934

Date	Number of days after sowing	Longleaf		Slash	
		Average top length	Average root length	Average top length	Average root length
		------Centimeters------			
May 16	19	4.1	5.5	4.6	4.1
May 21	24	4.6	6.6	4.8	7.1
May 26	29	4.8	8.7	5.0	9.9
May 31	34	5.0	11.3	5.2	9.9
June 10	44	5.6	15.2	6.4	13.8
June 20	54	6.3	21.6	7.1	15.2
June 29	63	1/ 7.1	27.9	1/ 6.3	16.0
July 10	74	6.6	27.3	7.8	18.4
August 8	103	11.9	31.8	13.1	21.4
September 11	137	19.3	32.4	18.1	22.8
October 8	164	22.9	1/ 31.3	26.1	24.8
November 8	194	24.4	37.9	28.0	29.7

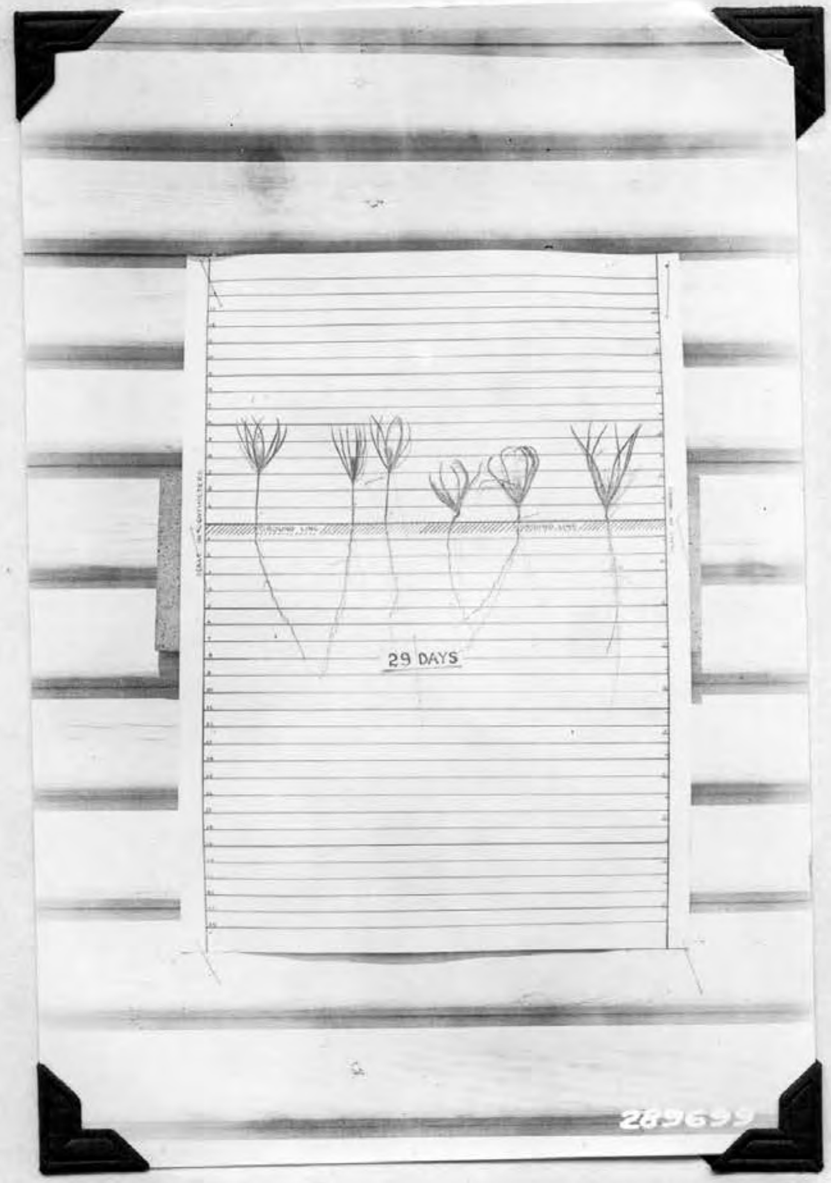
1/ Data out of line for unknown reason.



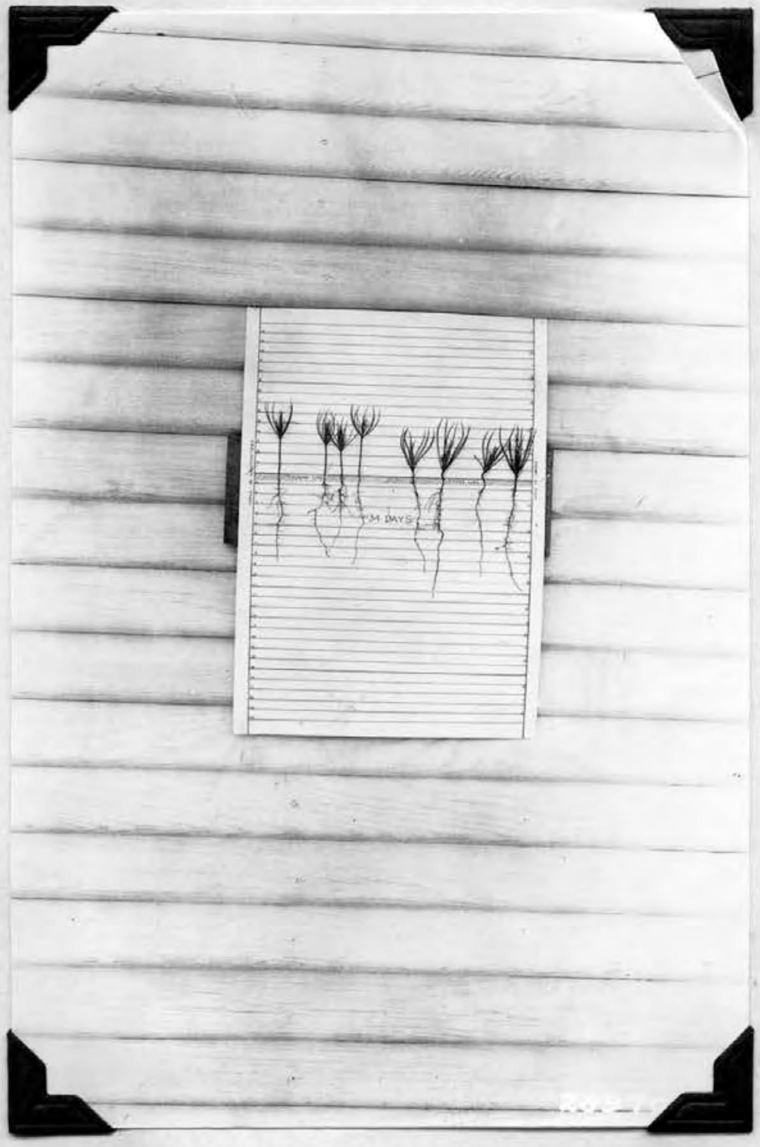
Life-history study. Slash and longleaf pines on May 16, 19 days after sowing.



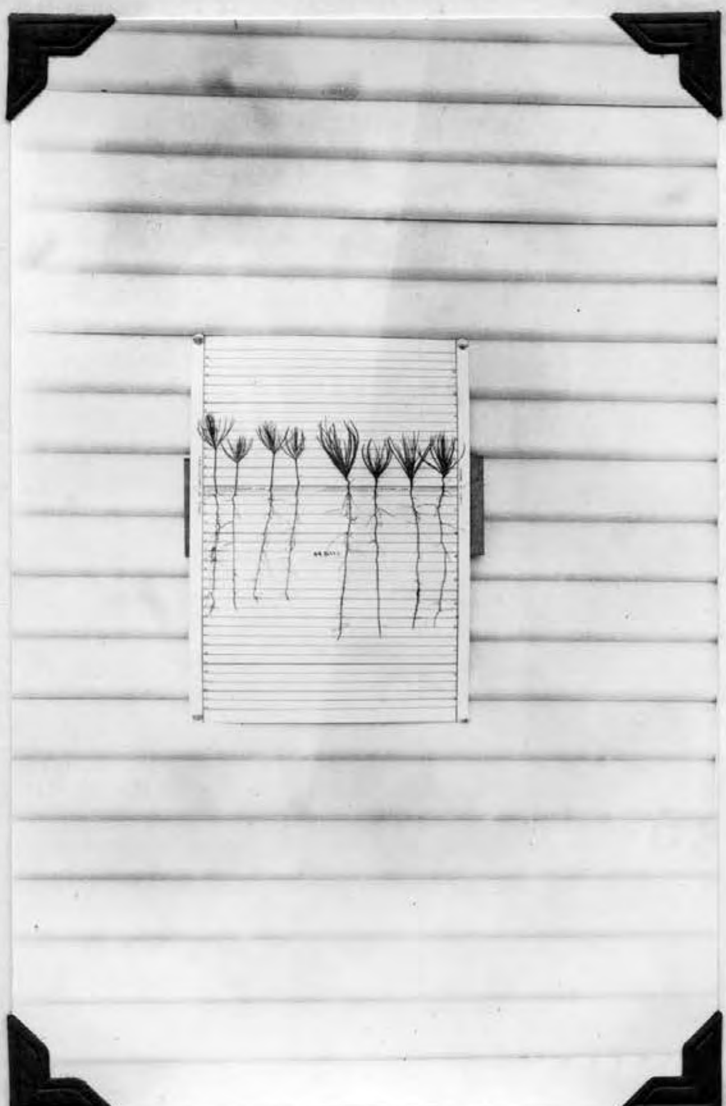
Life-history study. Slash and longleaf pines on May 21, 24 days after sowing. Primary needles are just beginning to appear between the cotyledons. Roots are elongating.



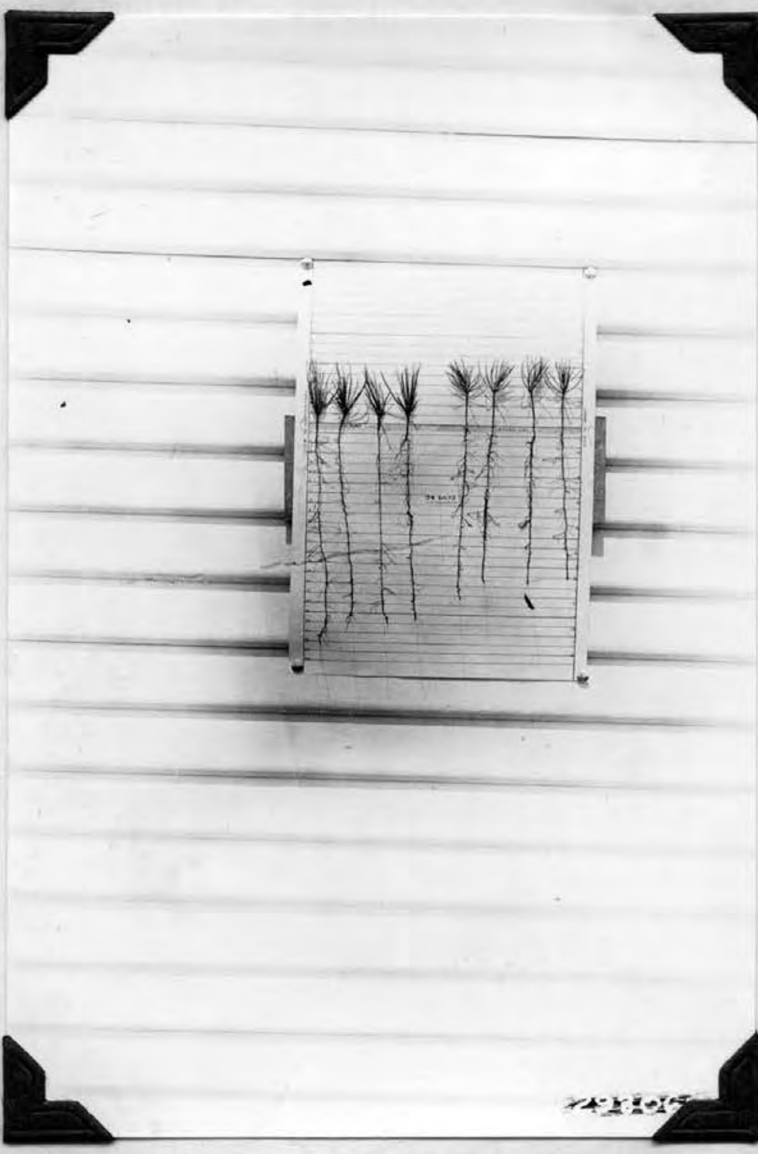
Life-history study. Slash and longleaf pine on May 26, 29 days after sowing. Primary needles are beginning to grow. Roots are elongating, and lateral roots are appearing.



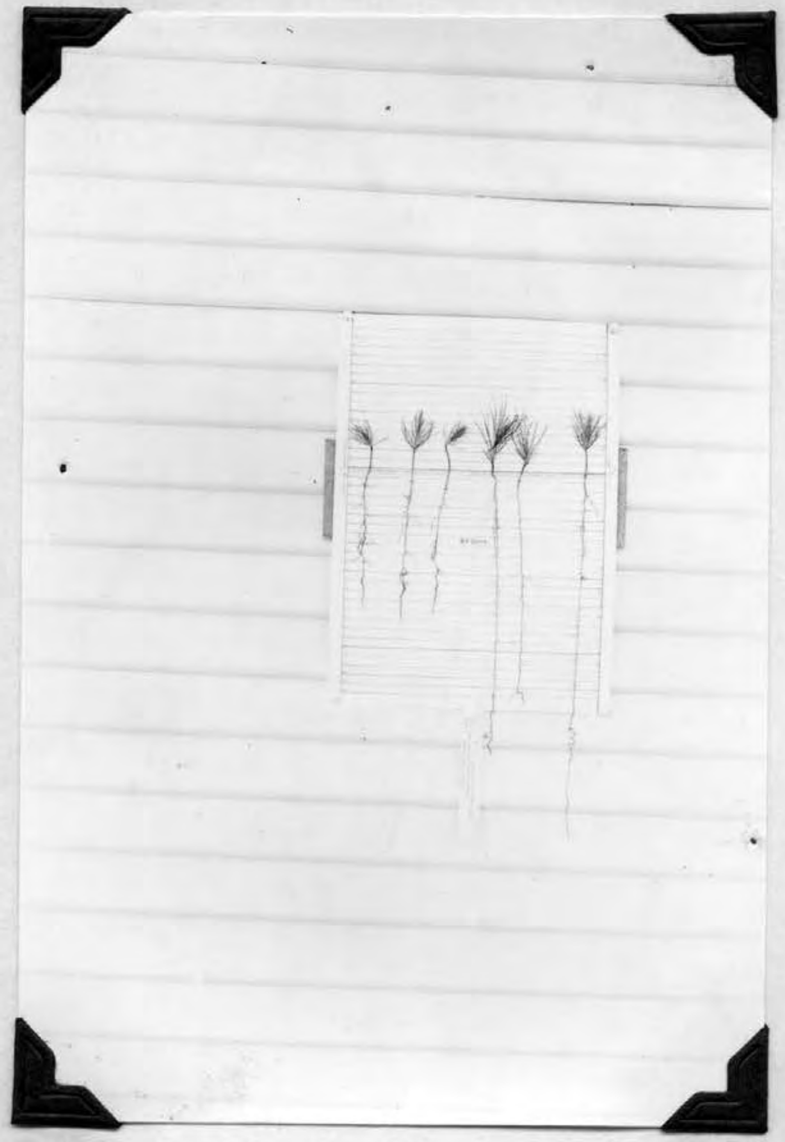
Life-history study. Slash and longleaf pine on May 31, 34 days after sowing. Primary needles and lateral roots are increasing in size.



Life-history study. Slash and longleaf pine on June 10, 44 days after sowing. Primary needles are increasing in number, roots are greatly elongating.

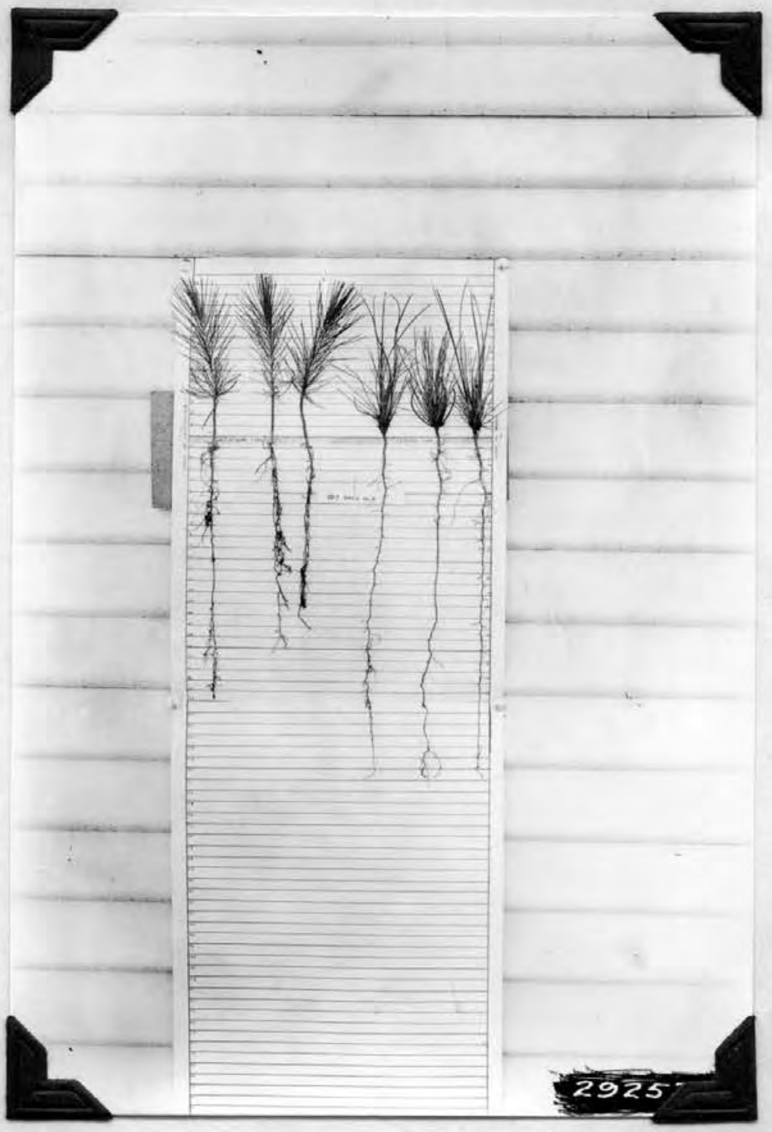


Life-history study. Longleaf and slash pine on June 20, 54 days after sowing. Roots of both species are elongating and laterals are increasing in number. Primary needles are elongating. Mycorrhizae appear on roots.

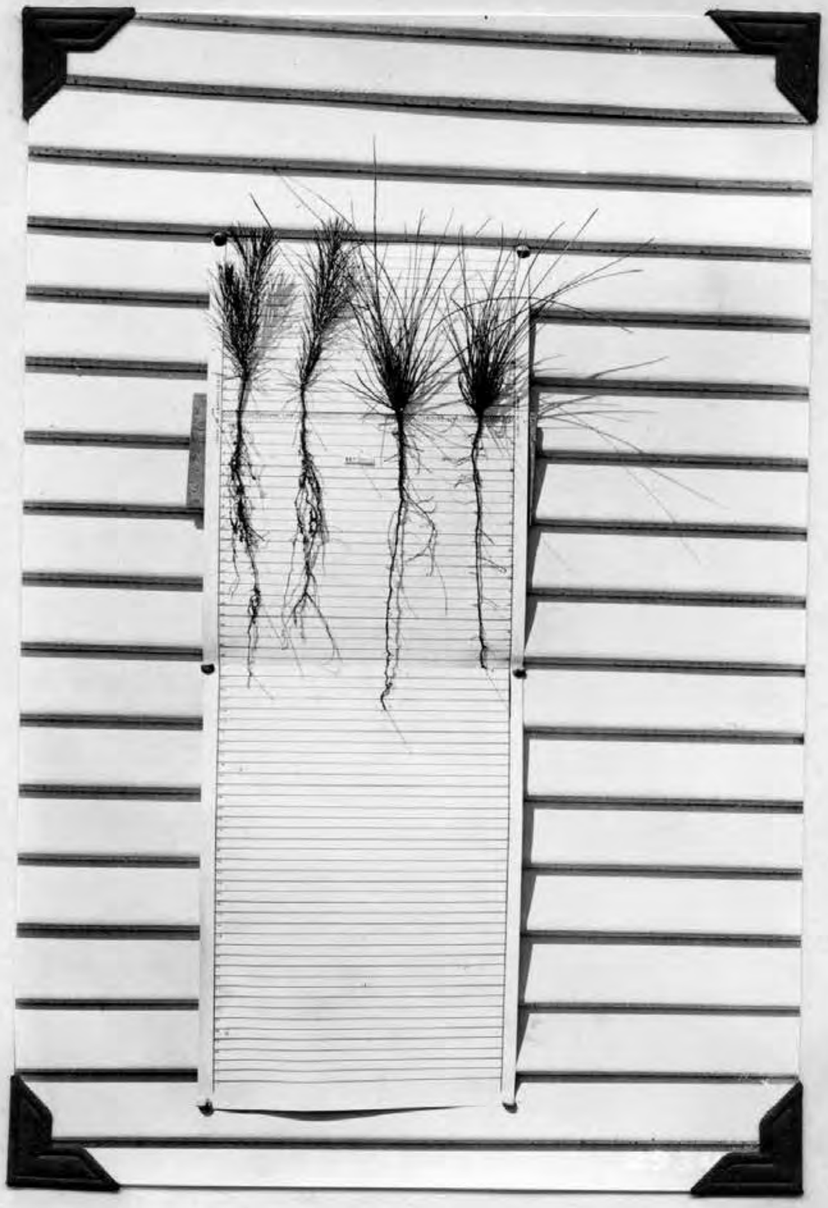


Life-history study. Slash and longleaf pine on June 29, 63 days after sowing. Roots of both species are elongating. Secondary needles begin to appear on longleaf.

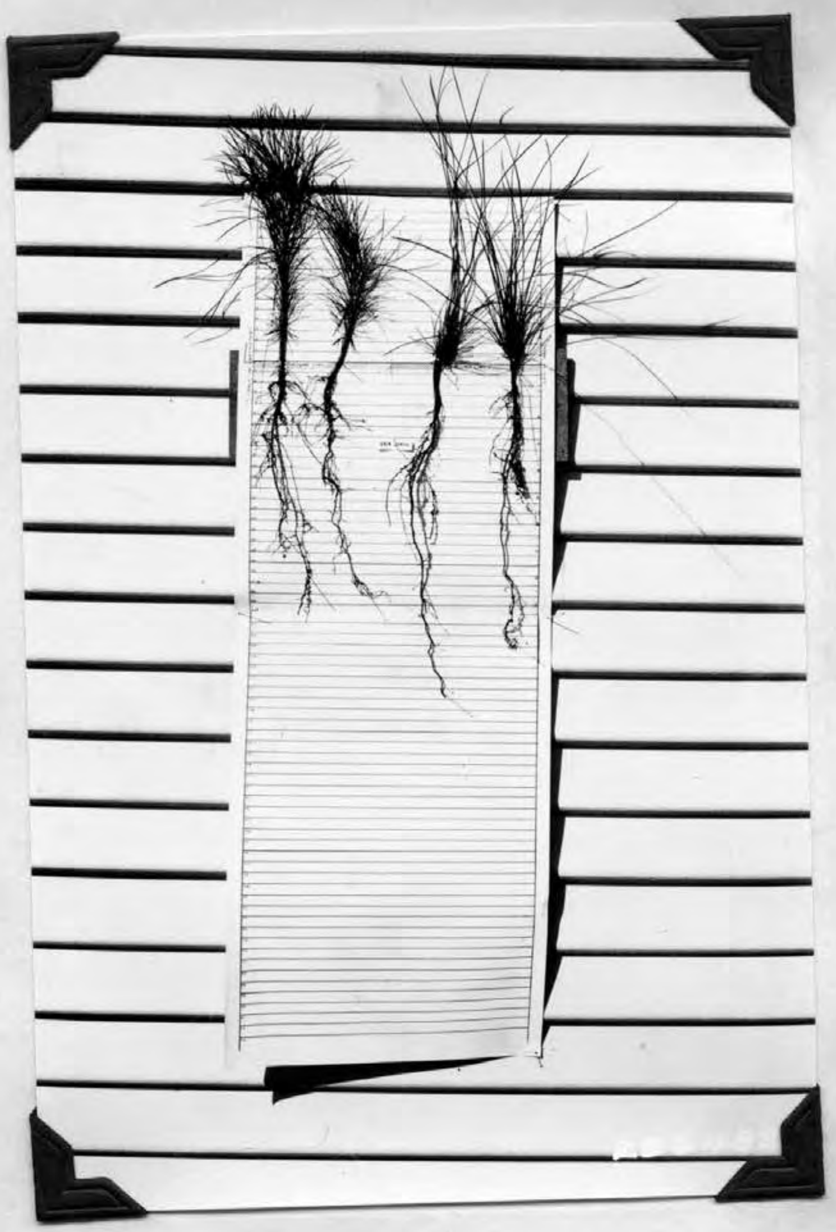
Life-history study. Slash and longleaf pine on July 10, 74 days old. Cotyledons are beginning to dry up and drop off. Roots of longleaf have entered into clayey subsoil and some have bent or curled in process of penetration.



Life-history study. Slash and longleaf pine on August 8, 103 days after sowing. Secondary needles appear on slash; those on longleaf increase in size and number. Stems are woody and bark appears. Diameter of stem and root-crown increases. Root elongation is becoming less rapid.



Life-history study. Slash and longleaf pine on September 11, 137 days old. Secondary needles in fascicles are elongating and increasing in number. Stems of slash are rapidly elongating. Diameter of woody stems is increasing. Roots of slash form a fibrous system, but elongation has almost stopped. Terminal bud is noticeable.



Life-history study. Slash and longleaf pine on October 8, 164 days old. Recent diameter growth of stem and root-crown has been rapid. Elongation of roots has been slow. Needle elongation is pronounced. Terminal bud is present.

Life-history study. Slash and longleaf pine on November 8, 195 days after sowing. Tops markedly developed. Terminal buds large. Root elongation proceeds again. Diameters increase.

Longleaf at the age of 122 days had well-developed fascicled needles about 15 to 20 centimeters in length; the terminal bud had appeared; the root was 25 to 30 centimeters long, with lateral roots; and mycorrhizae were pronounced. Bark had appeared on the roots and the diameter of the root-collar was beginning to increase.

The slash at this age had fascicled needles and the base of the terminal bud was about 10 to 15 centimeters high. Bark had appeared on the stem and the diameter of the stem was increasing. The primary root was about 20 to 25 centimeters in length and the lateral roots were developing.

Longleaf life-history plot, 122 days old.

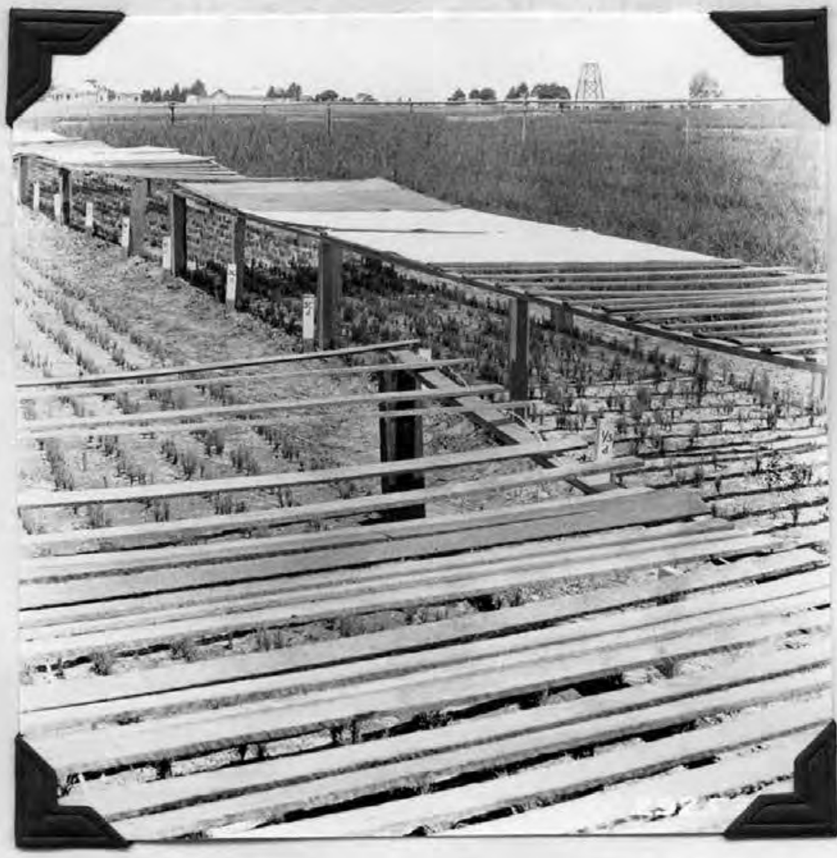
Slash life-history plots, 122 days old.

Shading

On July 20, 1934, after thinning all plots of longleaf to a uniform density of 35 per square foot, 4 plots of 4 by 4 feet for each treatment were shaded with one-half shade lath, one-third shade lath, one-fourth shade lath; single, double, and triple-thickness cheesecloth; and burlap. There was a no-shade check. The shades were removed September 15. The same treatments, with the exception of single-thickness cheesecloth, were given shortleaf pine on July 28, after thinning the beds to 30 per square foot. The shades should have been placed earlier.

The results, based on monthly and final measurements of height and stem diameter and on final plantable percentage, confirmed the current nursery practice of using no shade on longleaf. The shortleaf, especially since it was sowed late (April 14), showed a higher plantable percentage under one-half shade lath. This is being checked more thoroughly in 1935.

Shading studies in longleaf. 1934.



Shading studies in shortleaf. 1934.

This year, 1935, shading studies are being carried out on longleaf, slash, and shortleaf pine, using 4 replications of 4- by 4-foot plots. The longleaf was thinned to 18 seedlings per linear foot of drill or 36 per square foot, the slash and shortleaf to 20 per linear foot of drill or 40 per square foot, the first week in May. On May 7 the following degrees of shading were installed: Burlap, double-thickness cheesecloth, one-half shade lath, two-thirds shade lath, and a no-shade control. Records consist of daily maximum surface-soil temperature and weekly atmometer records of evaporation under each type of shade; monthly measurements of height and stem diameter; and final measurements of height, stem diameter, root length, and root extent; and plantable percentage. Unless there are outstanding differences, these studies will not be repeated in 1936.

Shading studies, 1935.

Density

Inasmuch as the final number of plantable trees in a bed at the time of lifting is often greatly reduced because of the crowded conditions during the growing season, studies were undertaken to determine the best density for growing seedlings.

In 1934, 4- by 4-foot plots, each treatment replicated 4 times, were thinned to the following densities: slash, 20, 24, 28, 36, and 40 seedlings per square foot, on July 23; shortleaf, 20, 24, 28, 32, 36, 40, and 50 per square foot, on July 28; longleaf, 10, 20, 30, 40, and 50 per square foot, on July 20.

Monthly measurements were made of height and stem diameter. Final measurements of height, stem diameter, and plantable percentage showed that the lower densities were preferable. Although the 1934 results were not so outstandingly significant as to warrant recommendations for thinning, they did indicate that longleaf and shortleaf do best if each seedling is allowed about 4 square inches of growing space and that slash does best at about 6 square inches per seedling.

These studies are being repeated in 1935.

Density studies in slash, 1934.

Density studies in shortleaf, 1934.

In 1935 these studies were repeated, using the following densities: longleaf, 10, 20, 30, 36, 40, and 50 trees per square foot; slash and shortleaf, 20, 28, 36, 44, 52, and 60 trees per square foot.

Density studies in longleaf, 1934.

In 1935 thinning was facilitated by the use of the McKellar thinning board on the drills. Nails (6-penny finishing) were driven into the boards (1 by 1-1/2 by 48 inches) at the desired intervals, one spacing of nails for each density used. The nails were spaced so that when there was one seedling in each opening, the desired density was obtained. The extra seedlings in each opening were cut off at the groundline with scissors.

Thinning shortleaf pine to uniform densities with the McKellar thinning board. 1935.

Top-dressing

In an attempt to increase the size of underdeveloped shortleaf and longleaf seedlings in 1934, potassium nitrate was applied in several concentrations as a top-dressing on July 14 for longleaf and on August 2 for shortleaf. The concentrations used were 6, 8, 10, and 12 grams per square foot, dissolved in 1-1/2 gallons of water, applied to 8 square feet. There were 4 plots 4 by 4 feet for each treatment, and 4 untreated checks. Alternate blocks between those treated were simply watered at the rate of 1-1/2 gallons per 8 square feet at the time of plot establishment.

The results of these applications were neither consistent nor significant--due, possibly, to lateness of application or to the low concentrations used. There was no marked increase in height, stem diameter, or plantable percentage as a result of the treatments.

Studies of effect of a top-dressing of potassium nitrate on shortleaf pine.

Weed Control

In an attempt to control weeds by chemical means, plots were treated with 6, 8, and 10 grams of zinc sulphate per square foot, and untreated check plots were included. None of the treated plots had many broad-leaved weeds, although grasses persisted. The untreated checks had a heavy crop of weeds. The germination of longleaf was low in all plots, but was lower in the treated than in the untreated.

This study is being greatly amplified in 1935 and 1936.

View of plots treated with $ZnSO_4$
(6b and 10b) and untreated check (X) showing
large number of weeds in the check. 1934.

The 1935 investigations of weed control included studies of (a) the occurrence and life history of weeds in the nursery and (b) the effect of various concentrations of zinc sulphate, zinc chloride, and sulphuric acid on germination and survival of weeds and pine seedlings.

The concentrations used were 6, 8, and 10 grams per square foot for zinc sulphate and sulphuric acid and 3.75, 5.00, and 6.25 grams per square foot for zinc chloride. Each treatment was replicated 4 times on 1- by 2-foot plots in wooden frames. Longleaf seed was sowed on one half of each plot and slash on the other half. Seeds of 3 weed species were sowed on all plots except 1 set of control plots. All the soil used in the plots was thoroughly mixed and steamed for 1 hour to kill all weed seed before treatment. Four plots were left without being subjected to steam.

Final results are not yet available.

Weed-control studies, 1935. The plots in the wooden framework are the chemical-control studies, the weeds in the center background are in the life-history study. To the right are seen the paper-mulch plots.

In 1935 mulch paper strips were placed between drills of longleaf, slash, and shortleaf pine to study the effect on occurrence of weeds. A comparison of time required to weed the mulched and unmulched beds has failed to reveal any advantage in mulching. The cost of mulch, and the labor required to apply it, are further disadvantages.

Use of paper mulch in an effort to reduce the number of weeds in the seedbeds. The mulch was ineffective.

Fertilizer Studies

With the objects of improving the planting stock and increasing and maintaining soil productivity at the nursery, experiments were undertaken (1) to determine the kinds and quantities of fertilizers needed to get the best possible quality of planting stock, (2) to test out several possible rotations of pine and green-manure crops, and (3) to ascertain the best green-manure crop for Stuart Nursery conditions.

The first object is being studied on 44 plots 4 by 5 feet, containing duplicates of 22 different combinations of N-P-K in the form of $NaNO_3$, sodium nitrate; $CaHPO_4$, acid phosphate; and KCl, potassium chloride (or muriate of potash). The plots are in wooden frames and longleaf, slash, and shortleaf pines are grown on all plots.

The second object, rotation, is being studied on 60 plots 4 by 20 feet, containing 5 replications of 6 treatments each. The treatments are:

1. Growing pine annually, unfertilized.
2. Growing pine annually, fertilized annually.
3. Growing pine alternately with cowpeas, unfertilized.
4. Growing pine alternately with cowpeas, fertilized cowpeas.
5. Growing pine 2 years, cowpeas 1 year, unfertilized.
6. Growing pine 2 years, cowpeas 1 year, fertilized cowpeas.

Thirty plots are given over to longleaf and 30 to slash. This experiment will continue for 10 years.

N-P-K fertilizer plots, in which long-leaf, slash, and shortleaf pines are growing. The Rotation plots are seen at the left.

Above

N-P-K fertilizer plots, in which longleaf, slash, and shortleaf pines are growing. The rotation plots a the left.

Taking soil samples from the N-P-K plots for analysis. The auger brings up a boring of soil 0"-6" deep. For each plot sample 5 such borings are made and thoroughly mixed for a compoite sample. The samples are later chemically analysed.

Left

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The third object, or green-manure-crop phase, is being studied on 40 plots 4 by 5 feet containing 5 replications of 2 degrees of sowing of 4 species of green manure. The species and rates of sowing used are:

	Light sowing	Heavy sowing
Cowpeas, whipporwill	1 bushel per acre	2 bushels per acre
Velvetbeans	1 ~~peck~~ bushel per acre	2 ~~pecks~~ bushel per acre
Crotalaria	10 pounds per acre	15 pounds per acre
Sesbania	10 pounds per acre	15 pounds per acre.

The first crop was sowed April 30, and was dug, weighed, and spaded under on August 10. The second crop was sowed August 26, 1935.

In 1936 these plots are to be sowed to slash pine.

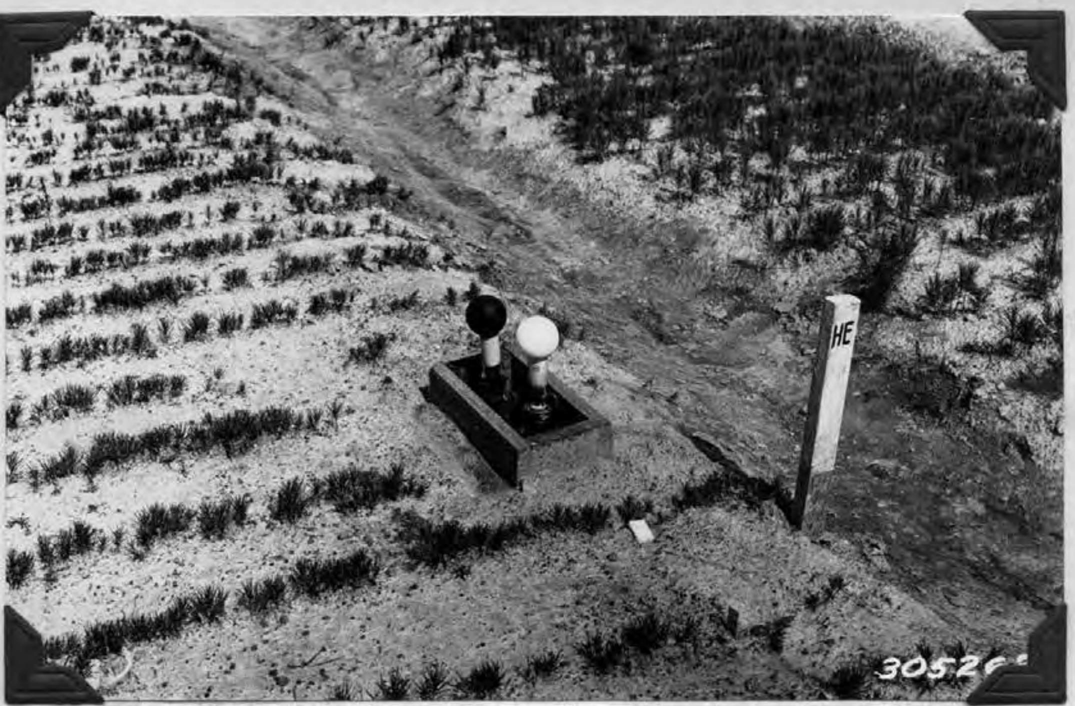
Green-manure phase of fertilizer study, showing cowpeas, velvetbeans, Crotalaria, and Sesbania.

Miscellaneous Studies

To obtain information as to the conditions under which the seedlings are growing, various instruments are used. Among them are the Livingston black and white porous clay atmometers, which measure evaporation.

The atmometer cup, filled with distilled water, is continuous through a glass tube into a reservoir bottle. At the lower end of this glass tube is a mercury-valve to prevent the entrance of rain water. A rubber stopper holds this tube and valve in place in the reservoir bottle. As the sun and wind strike the bulb, water is evaporated; the bulb is kept supplied from the reservoir. The amount of water lost in a given period is the evaporation during that period. The black bulb absorbs the sun's heat while the white bulb reflects it. From the difference between the corrected evaporations, evaporation and insolation data are computed.

In addition to atmometers, maximum soil thermometers and a recording instrument which provides records of surface-soil temperature, air temperature, and air humidity are also used.



Black and white porous clay cup atmometers to measure evaporation.

~~Black and white porous clay cup atmometers to measure evaporation.~~

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Recorder to measure surface soil temperature, air temperature, and air relative humidity.

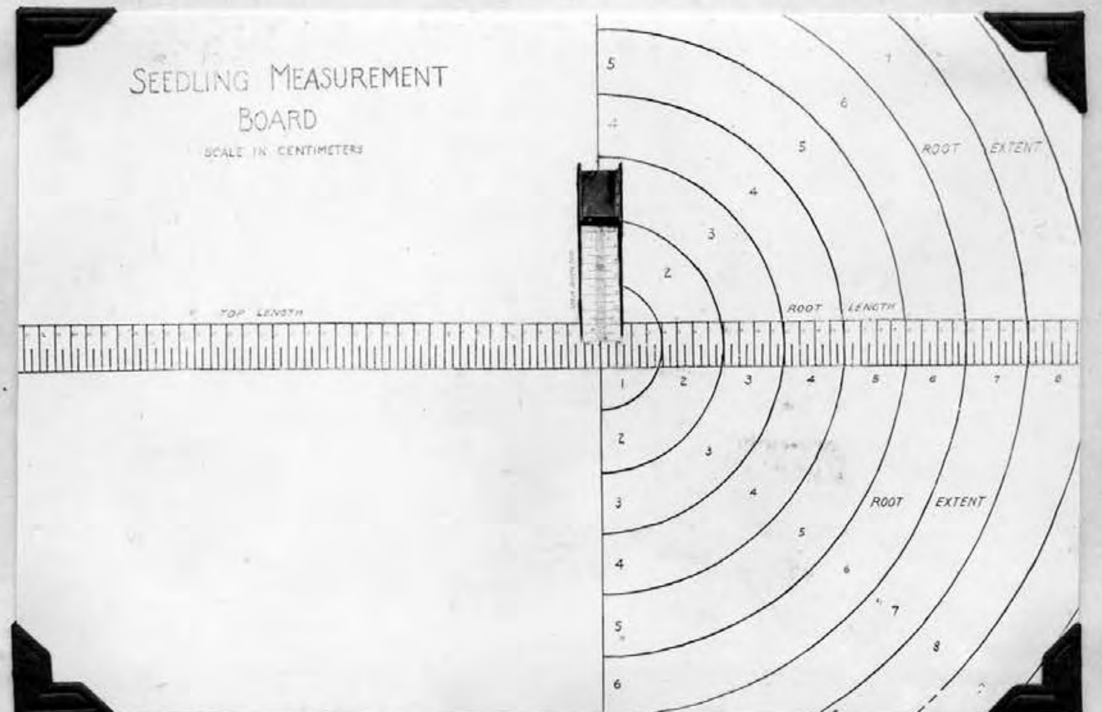
Seedling Measurement Board[1]

To facilitate the measurement of a large number of seedlings, this board was designed to measure top length, stem diameter, root length, and root extent in a single operation.

In using the board, the seedling is placed against the two nails in the center with the groundline at the zero mark. The black diameter-slide is moved snugly against the stem which is braced against the nails. The roots are spread out in as nearly natural a position as possible. The top length, stem diameter, and root length are read off directly. The root extent is obtained by tallying the number of rootlets ending in each circle. These numbers are then multiplied by the radii of the corresponding circles and the products totaled for the root-extent index.

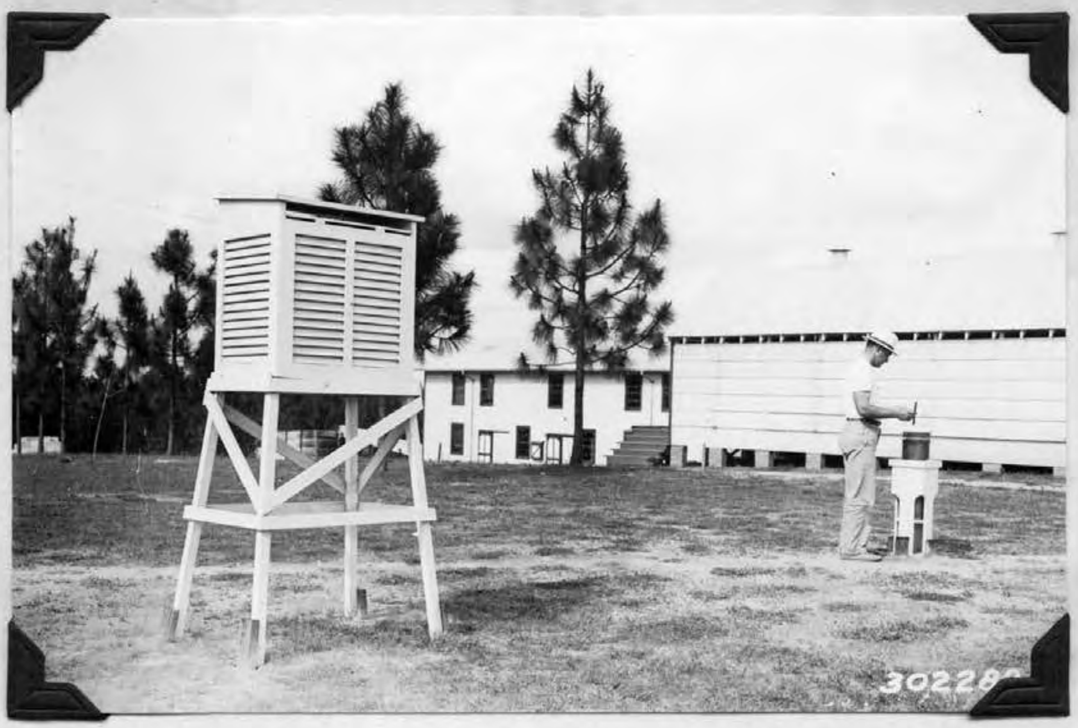
The board can also be used advantageously as a scaled background for photographing seedlings.

1/ Huberman, M. A. A seedling measurement board. Southern Forest Expt. Sta. Occasional Paper No. 44, 4 pp., illus. March 20, 1935.



Seedling measurement board to facilitate measuring dug seedlings.

On April 1, 1935, the Cooperative Observer Weather Bureau Station was set up at the nursery. Daily records are kept of maximum and minimum temperatures, precipitation, prevailing wind direction, and character of sky. The readings are made daily at 5 p.m. by one of the experiment station or nursery staff members.



The Cooperative Observer Weather
Bureau Station at the Stuart Nursery.

On January 21, 1935, before the weather station had been set up at the nursery, a 5-inch snow fell, and stayed on the ground for 5 days. This was "very unusual for this time of year." There has been no recurrence of such a snow since the weather station has been in operation.

Snow at the Stuart Nursery on January 21, 1935.