NORTH CAROLINA AGRICULTURAL EXTENSION SERVICE

ANNUAL REPORT

AGRICULTURAL PRODUCTION
MANAGEMENT AND NATURAL RESOURCE USE PROJECT (III)
Title of Project

Forestry
Section

1964
Annual Year

Name and Title of Worker	Percentage of Time Devoted to Entire Project by Each worker
W. M. Keller In Charge, Forestry Extension Project Leader	100 %
Forest Management Extension Specialists	%
J. C. Jones, Head	100 %
E. M. Jones	100 %
F. E. Whitfield	100 %
Leonard Hampton	100 %
W. M. Stanton	100 %
Ross S. Douglass 1/	100 %
John Gilliam 2/	100 %
William B. Stuart 3/	100 %
	%
	%
	%
	%
	%
	%
	%
	%
	%
	%

1/ On study leave 1/1 - 10/30, 1964
2/ 1/1 - 6/30, 1964 - Resigned
3/ 7/1 - 12/30, 1964

Signed _____
Project Leader

Date Submitted _____

ANNUAL REPORT

FARM FORESTRY EXTENSION WORK

NORTH CAROLINA

January 1, 1964 - December 31, 1964, Inclusive

Walter M. Keller, In Charge, Forestry Extension
J. C. Jones, Head, Forest Management Extension Section

George Hyatt, Jr., Director

N. C. Agricultural Extension Service
N. C. State of the University of North Carolina
at Raleigh
and
U. S. Department of Agriculture, Cooperating

State College Station
Raleigh, N. C.

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ANNUAL REPORT

FOREST MANAGEMENT SECTION

AGRICULTURAL PRODUCTION, MANAGEMENT AND NATURAL-RESOURCE USE (III)

1964

Walter M. Keller, In Charge, Forestry Extension
J. C. Jones, Head, Forest Management Extension Section

I. Program Accomplishments

A. There are over 200,000 owners of farm and other small woodlands in North Carolina. It is from these landowners that industry will procure the wood fiber needed to meet the product demands of the consumer. It is from these same lands that other forest products must be produced for the buying public, such as Christmas trees and seasonal decorations.

To grow forest products of acceptable quality, in both hardwoods and softwoods, there must be improved management of all lands. Landowners who need and request assistance should receive it through well-informed Extension agents and professionally trained foresters. The Forest Management Extension Section personnel are directing their efforts toward the fulfillment of these needs.

This report will deal with the following major areas of interest:

1. The development of a sound business approach to, and increased efficiency in, forest management and forest development.

2. The cooperative bottomland hardwood management study by the School of Forestry-Extension Forestry Department with several major hardwood-using companies.

3. The development of a large-scale Christmas-tree enterprise in the mountain area.

4. Reduction of losses caused by forest diseases, insects and storms.

5. Outdoor recreation opportunities for private landowners.

6. The development of an educational program in logging and logging safety.

1. <u>The Development of a Sound Business Approach to, and Increased Efficiency in, Forest Management and Forest Development</u>

When a landowner wishes to develop a commercial timber-growing enterprise as a sound investment capable of producing an attractive return on his capital and time, he must determine the productive capacity of the soil and the management practices necessary to grow such a tree crop.

To create an awareness of the importance of soils

and good forest management practices, the following things were done:

a. A training school on soil site index and forest management economics was held November 17, 18, and 19, at the Kinston training facility for twenty management foresters of the North Carolina Forest Service. Basic information about soil characteristics and how they influence tree growth was presented, along with economic analysis of forest investment. (Exhibits A-1 through A-5)

b. In Granville County a demonstration was given on the land of Mr. Richard Hémme in converting low-value hardwood areas to pine production. Through the cooperation of Albemarle Paper Company, who furnished a heavy crawler tractor with a KG blade, approximately four acres were cleared of remaining trees and brush after all merchantable wood was removed. Seventy landowners attended this demonstration. The area cleared on Mr. Hémme's land will be used to establish a result demonstration of different tree species to show their comparative suitability in this area on such a site.

The importance of soil site index as it relates to the economics of timber production was discussed at an evening meeting in the Granville County Agricultural Building.

c. The meaning and importance of soil site information in forest management from an economic viewpoint were discussed in a program presented to the Central North Carolina Forestry Club meeting at Southern Pines. Twenty foresters and others in allied occupations showed much interest in this presentation.

d. At a meeting of Pender County landowners the economic importance of soil site information in considering investment in forest management practices was stressed, along with information about forest insect and disease control. The next day a tour through the Riegel Paper Company mill at Bolton was conducted for twenty Pender County landowners. After this tour the group visited drainage operations, plantings, and several pine plantations of various ages. Drainage of forest land is an important management practice in Pender

County. This tour was designed to show the benefits of drainage work to timber production.

e. A television program on tree-seed collection, nursery operations and planting of the seedlings was produced on the Consolidated University of North Carolina educational station. These programs are also carried over seven commercial television stations.

f. The soil site index-economic analysis approach to timber production was presented to the Wayne County Forestry Club, the School of Agriculture's appraisal class in the Department of Agricultural Economics of North Carolina State, and meetings held in Yadkin County and Chatham County.

g. In timber stand improvement work demonstrations of the mist blower as a method for chemically controlling undesirable brush and small hardwoods were given in Moore, Sampson, Lee, and Richmond Counties.

On the Penland farm in Buncombe County, a mist blower demonstration was done over approximately five acres of Fraser fir Christmas trees to control unwanted brush and briars.

A similar demonstration to show chemical site preparation for planting was done on the Vernon Peterson farm in Buncombe County. White pine was planted after the demonstration. Observations six weeks after mist blowing show satisfactory results.

This phase of the department program was given leadership by Ross S. Douglass, with all other staff members assisting.

h. The coastal strip of the outer banks region in North Carolina is constantly under tremendous erosion pressures. Stabilization of the sand in this region has been an expensive, as well as a perplexing problem for the landowners in recent years.

Mr. L. E. Adams, owner of the Whalehead property on the Currituck outer banks attempted to solve the erosion problem several years ago by planting several hundred thousand tree seedlings. Redcedar, loblolly, longleaf, slash, and maritime (P. pinaster) pine were the various species planted in the sand-dune area. The progress of these plantings has been followed very closely by Extension foresters.

The maritime pine has proven to be the most

tolerant to salt-spray damage, as well as having favorable growth for a deep sandy soil. However, this exotic species has proven to be very susceptible to attack from the pine-cone moth (Dioryctria) This insect was identified by Fred Whitfield this year on a planting in Dare County.

The North Carolina Forest Service nurseries grew maritime seedlings for distribution this year. Through the efforts of Extension foresters, demonstration plantings were made in all of the coastal counties. Three of the counties purchased several thousand seedlings for distribution within their area.

All county agents were made aware of the insect problem inherent with the plantings. A simple spray schedule for the control of the pine-cone moth was worked out by Whitfield. However, the area residents were so pleased to have something attractively green in the dead-brown coastal winter months that a spray program is assured.

The maritime pine plantings were not recommended as a solution to the erosion problem. Grass stabilization is more efficient. However,

they will assist in the problem and serve as an attractive windbreak and ornamental as well.

i. Ample pine seed-producing trees, a well-disked seedbed and yet few pine seedlings showing. This was the situation which confronted Mr. Harold Moore of Hertford County. He was contemplating redisking the 25-acre area and planting loblolly pine seedlings. First, he felt that maybe a professional forester's recommendations might be helpful.

Mr. Moore contacted his county Extension chairman, who, in turn, requested the assistance of the Extension forestry specialist. The Extension forester's examination confirmed Mr. Moore's findings. However, where he found a 10 per cent pine reproduction, he also found a 90 per cent yellow poplar reproduction. The soil, moisture, and drainage were ideal for optimum poplar growth. The Extension forester also informed Mr. Moore of the optimistic projected demand for poplar and recommended that the present reproduction be allowed to remain. The landowner was very pleased to accept this recommendation.

be more than enough to pay for the college education.

Since the thinning demonstration six years ago, Mr. Griffin has put 1400 forested acres under intensive management. Where the Jones County average annual return is 90 cents per acre, his estimated annual return is $6 per acre.

The Extension forester, along with the county Extension chairman, has worked with Griffin in setting up demonstrations on:

KG blade site preparation
Disking for site preparation
Control burning
Mist blowing to release seedlings
Chemical control of undesirable hardwoods using pellets, liquids and powder
Christmas-tree variety plantings
Variety of species plantings on various soils
Direct seeding
Non-commercial thinning

The Griffin farm serves Extension as a reference for what an individual woodland owner can do using off-season labor and initiative. This year, a Forestry Promotion Day was held on the farm. Selected county agricultural workers and five selected farmers from each of the eight Neuse Area

Development counties spent a day touring the Griffin forestry operation. The tour was well covered with a television feature and with newspaper and radio representatives. The day was climaxed with a talk on the economics of forestry by state Extension forester, W. M. Keller.

Certainly, W. V. Griffin's enterprise is adequate testimony that proper forestry management for the individual landowner can be profitable.

These three landowners were given leadership by W. M. Stanton, with assistance from other staff members.

j. Polk, Chatham, and Wilkes Counties held a Forestry Emphasis Week during 1964. In each county a week was devoted to emphasizing the importance of the forest and its products by the county Extension office, schools, interested groups, and individuals with assistance from industrial foresters and Extension forestry specialists. During the week each school was visited and a class on forestry held. Programs were presented to civic clubs and Boy Scout troops. Publicity was given through all news media in the area.

A forestry field day was held in Mitchell County for the fifth and sixth grades from all the county schools.

L. A. Hampton prepared "Forestry Program Projections" for Henderson and Caldwell Counties.

This phase of the department program was given leadership by L. A. Hampton with assistance from other staff members.

2. The Cooperative Bottomland Hardwood Management Study by the School of Forestry-Extension Forestry Department with Several Major Hardwood-using Companies

The establishment of this study and the first interim progress report on the program were reported in the 1964 annual report.

The first annual report on this program has been submitted to the participating companies and is herewith submitted as Exhibit A-6.

E. M. Jones serves as associate director of this program.

3. To Increase Production of Quality Christmas Trees and Develop Christmas-tree Markets and Marketing Techniques for Trees Produced in North Carolina

a. Assistance was given to Russell Beutell in Jackson

County in sales promotion of his Fraser fir planting stock. As reflected in the 1963 annual report, this privately owned commercial nursery transplanted approximately one-half million 2-0 Fraser fir in the spring of 1963 to supplement the production of Fraser fir at Holmes Nursery.

A detailed management plan that was prepared by the Extension forestry specialists was instrumental in securing adequate financial assistance for Beutell's nursery operation.

This nursery operation will provide approximately one-half million 2-2 Fraser fir for sale to growers in the mountain area in the spring of 1965.

b. Plans were made to promote the planting of at least 700,000 Fraser fir and 1,500,000 additional seedlings for Christmas trees from amont these species: white pine, Scotch pine, white spruce, Douglas fir, Norway spruce, Serbian spruce, and redcedar.

Assistance was given in the sale of the following seedling stock produced in state nurseries:

Fraser fir --------	435,000
Norway spruce -----	12,000

White pine -------	118,000
Redcedar ---------	339,000
Arizona cypress --	157,000
Scotch pine ------	166,000
Total	1,227,000

An estimated 100,000 seedlings were ordered from private nurseries and planted in western North Carolina. These species were primarily Norway, white and blue spruce, and Scotch pine.

Methods used to promote the tree-planting program were: news articles, radio, television, group meetings, newsletters, personal contacts, demonstrations.

c. Landowners in the mountain counties were to be assisted in increasing income by at least $250,000 in 1963-64 through the sale of both bagged Fraser fir and sheared white pine.

An estimated $250,000 additional income is a conservative figure for cut-and-bagged Fraser fir and white pine. For the first time, white pine was sold on the retail lot in several locations in North Carolina. Fraser fir was reported the top tree in demand; and most retail lots reported good sales for both species, including some burlapped trees. Buyers reported that top-quality

trees of both species were short in supply in the salable size of 6' - 7' class.

Christmas-tree sales of good-quality sheared white pine indicate an increase in popularity for this species. There has been an increase in demand for Fraser fir and white pine by out-of-state buyers.

d. A leaflet entitled "Buy North Carolina-Grown Christmas Trees" (Exhibit A-8) was prepared and distributed to the Federation of Women's Clubs in North Carolina, county agricultural Extension agents, and others to help stimulate the demand for North Carolina-grown trees. Requests for over 3,000 copies of this leaflet have already been received through the Publications Department.

Shearing and improved management techniques have vastly increased the quality of plantation-grown trees, and continues to make them more attractive to the buyer.

Methods used to increase the income from these species include:

Demonstrations in shearing techniques
Newsletters to growers

Personal contacts with growers and buyers
Group meetings with growers to discuss cultural practices necessary to produce quality trees
Printed material on management, cultural practices, harvesting and marketing

e. Study plots in Christmas-tree plantations on fertilization and the use of chemicals to control weeds and blackberry briars are continuing. These studies were reported on in the 1962-63 annual reports. Two new fertilization study plots were established - one in Haywood County and one in Avery County - using a new high-nitrogen, slow-releasing pelletized fertilizer.

f. Christmas-tree production and marketing meetings were held in the following counties: Transylvania, Alleghany, Clay, Cherokee, Watauga, and Buncombe.

g. Christmas-tree shearing demonstrations were held in Transylvania, Avery, Jackson, and Henderson Counties.

This phase of the department program was given leadership by L. A. Hampton, J. H. Gilliam, F. E. Whitfield, and R. S. Douglass.

4. Reduction of Losses Caused by Forest Diseases, Insects and Storms

The southern pine beetle infestation that became epidemic two years ago and then subsided, reached epidemic proportions again in 1964 in several counties. The counties hardest hit were Davie, Davidson, Guilford, Forsyth, Yadkin, and Randolph, all in the piedmont area of the state. Infested areas showed up in Granville, Chowan, and Beaufort Counties.

To keep landowners informed about the insect infestations, the Extension forestry specialist prepared and gave a television program that was carried over one educational and seven commercial stations. Emphasis was placed on early identification of the attack and the importance of immediate control measures. A news article was prepared and released through evening newspapers throughout the state. This article was also carried by the newsletter of the Plant Food Institute and Wachovia Bank & Trust Company. Steps that landowners should take to reduce damage from these insects were listed in the article.

A serious attack of pine bark beetles that occurred in the southern part of Moore County as a

result of a 30,000-acre forest fire was reported in the 1963 annual report. Follow-up work by the Extension forestry specialist, county Extension personnel, and industrial foresters permitted an orderly salvage of timber in the damaged area. A television program was produced showing the extensive economic losses caused by this fire and how it affected the personal lives of some of the residents in the area.

The balsam woolly aphids continued to spread in the Fraser fir stands of western North Carolina. They have now infested trees on Mt. Mitchell State Park, the Pisgah, Nantahala, and Cherokee National Forests, the Blue Ridge Parkway, and the Great Smoky Mountains National Park. These insects have also spread to privately owned trees in Watauga, Avery, Mitchell, Yancey, Caldwell, and Burke Counties. Inasmuch as there is no practical way known to control these pests, the seed source of these valuable trees is being threatened.

To inform the public of the ravages of the balsam woolly aphid, the Visual Aids Department assisted in preparing a film and slide set. These slides and

This phase of the program was given leadership by Fred E. Whitfield.

5. Outdoor Recreation Opportunities for Private Landowners

"Variety Vacationland" is the welcome sign one reads as he enters North Carolina. Very few states can offer the variety of outdoor recreation resources that North Carolina has stretching over a width of 500 miles from the seacoast to the mountains. Also, because of its width and location, nearly all of the interstate north-south traffic passes through the state. Therefore, there is unlimited potential to attract the recreation dollar to the region.

Most of the efforts of the Extension forestry staff have been directed toward creating an awareness of the opportunities in outdoor recreation enterprises within the state. Also, much effort was directed toward informing the public of existing facilities and their locations.

Information and research data on forest recreation are very limited. All opportunities to become better informed in this field were eagerly pursued. A five-day regional workshop at V. P. I. was attended

by Extension Forester W. M. Keller. Forest Management Specialists Hampton, Jones, Stanton, and Whitfield had a three-day workshop with the U. S. Forest Service recreation project leaders in western North Carolina and eastern Tennessee.

A three-page "Forestry Facts" sheet relating the opportunities and precautionary pitfalls in establishing camping facilities was prepared by Stanton. This was distributed to each county and to interested persons within the counties.

An inventory of existing outdoor recreation facilities where a fee was charged was made with the assistance of each county Extension chairman. This will serve as a basis for recommendations for future recreation ventures.

Nine television programs were presented throughout the state with emphasis on a forest-environment recreation. Publications relating the camping opportunities in the many state and federal parks and forests within the state were offered the viewers upon request. Better than 500 responded to the invitation.

Dare County Agricultural Workers' Council had a

theme for their state fair exhibit, "Outdoor Recreation." Mr. Stanton served as a member of the planning committee.

A planning session on recreation enterprise possibilities was held by Mr. Stanton and Wildlife Specialist Hugh Fields for the agents from Durham, Orange, and Person Counties.

The multiple-use aspect of forestry management which includes recreation and wildlife, has been stressed at all forestry training sessions. This is most evident with youth work.

This phase of the department program was given leadership by W. M. Stanton.

6. <u>The Development of an Educational Program in Logging and Logging Safety</u>

This program began intensive development in July of this year. Much of the past six months has been devoted to program development and planning. A considerable amount of this time has been spent in developing educational material, case histories, time-study techniques, visuals, et cetera.

The objectives of the logging program are essentially twofold: First, to carry out an educational

program aimed at loggers, land managers, and other concerned individuals. This program is essentially operations planning and control, and the development of skills necessary to apply these techniques. Second, to develop an intensive logging safety program which will significantly lower the workmen's compensation rates for the state of North Carolina.

The logging industry depends upon a wide variety of production units producing essentially the same product - roundwood. North Carolina's wood-using industries are dependent upon this wide variety of production units for their raw-material supply. These production units may vary in size and equipment investment from one man with less than $500 invested in equipment to some large independent producers employing twenty or more men with several hundred thousand dollars invested. This variety, in turn, gives rise to numerous logging "systems." A system can best be described as the manpower and equipment allocation involved in moving the roundwood from the stump to the market.

A casual survey of the systems supplying a particular pulpwood yard - the Albemarle Paper Manufacturing

Company's yard at Kinston, N. C. - on a given day this summer disclosed that there were seven different types of systems involved in supplying that yard. This classification is very broad. Placing more restrictives on this would have shown that each producer has a unique system which he had developed in other unrelated industries, and one of our major considerations should be the adaption of these techniques to make them applicable to logging.

During the summer of 1964, two cooperative studies were conducted with the Albemarle Paper Manufacturing Company, the School of Forestry, and Forestry Extension. One of these was conducted in Lenoir County. The immediate purpose of this study was to develop valid data on the cost of producing multiple-length pulpwood and at the same time compare the relative costs and efficiencies of producing pulpwood using a Montague mill, a strictly multiple-length or longwood operation, and an integrated operation producing both longwood and sawlogs.

The second study conducted from the Joyland Yard in Durham and concentrated primarily in Durham County

was on the tilt-fork logging operation. This study was again conducted for the primary purpose of developing cost data on producing pulpwood through this method and to try to pinpoint some of the inefficiencies in these operations. Extension had a secondary interest in this study - mainly, the opportunity to develop and test standardized continuous timing methods for logging. (See Appendix.) The data developed from this study will be used in future for comparisons and as material for educational programs.

A third study is now in progress with Albemarle (Exhibit A-7). This involves work-sampling techniques by company personnel as a method of evaluating the relative efficiencies of their producers. This is of particular importance to future programs because this is to be a long-term survey which should pinpoint many of the inefficiencies in the various systems studied and serve as an indicator for educational programs. Since the study may be continued for an indefinite period, it will also serve as a tool for evaluating the impact of these educational programs on the producers of one particular company.

One cooperative program has been put into operation (Exhibit A-8). This is with J. H. Dunn of Scotland Neck in Halifax County. Mr. Dunn is a pulpwood dealer who has a pulpwood and logging crew under his control. He also works closely with Odell Bunting, owner of the Bunting Lumber Company in Scotland Neck, with whom we hope to be working in the near future. These two men have been chosen as long-term cooperators because of their earlier contacts with Extension, their desire for assistance and willingness to cooperate, and the equipment-spread at their disposal.

Two visits have been made with Mr. Dunn. The first was for the purpose of getting acquainted with Mr. Dunn and his operations. On the second visit, several days were spent with his pulpwooding crew timing portions of his operations, doing a field analysis of the data, and discussing the findings of this survey and possible ways of improving his operation. These improvements involve several considerations: the reallocation of some of this equipment, a change in some of the hand gools, and providing more safety equipment for his woods crews.

The impact of this visit cannot be measured yet, but the effect of a continuous program of this type of work should be reflected in the total production of the crew and the profit per cord from the operation.

Since Mr. Dunn and Mr. Bunting can be considered typical or representative of the size and the type of loggers prevalent in North Carolina, our contacts with them should be particularly useful in the future for developing not only evaluation techniques but also educational and cooperative material.

The Safety Program

A concentrated safety program is needed for the logging industry in North Carolina. Plans are being formulated for Extension to develop an intensive educational program in the principles and practices of safety within the industry.

The workmen's compensation rates for the logging and pulpwood industry in North Carolina is now about $13.50 per hundred dollars of payroll. As a comparison, the workmen's compensation rate for the textile industry is 15 cents per hundred dollars of payroll.

Any reduction in this workmen's compensation rate for the logging industry, which is essentially an operating cost, which a safety program could bring about, would be very meaningful for the industry as a whole. This program is badly needed for both economic and humane reasons. At present, this program is being developed; and several contacts have been made and areas of operation opened. We have been assured cooperation from the American Pulpwood Association, American Mutual Insurance Company, and the Department of Labor for North Carolina.

This phase of the department program was given leadership by W. B. Stuart.

B. In addition to the six major areas of interest reported on, the department was involved in many other activities. Some of these are reported very briefly in the following paragraphs:

1. One of the Extension forestry specialists, faculty members of the School of Forestry of North Carolina State, and personnel of the North Carolina Forest Service, in cooperation with private landowners, selected Fraser fir trees to be transplanted to a seed-

orchard site selected in Henderson County. The seed-orchard area is located on state-owned property close to the Penrose Nursery site. Intensive care of the orchard can be given by the State Forest Service at this location.

The trees selected were made available by private nurseries and landowners. The trees, 4 to 6 feet in height, were graded for suitability for Christmas trees by faculty members of the School of Forestry (Exhibit A-9). Trees that were rated "acceptable" came from seven different locations in Watauga and Avery Counties.

This program of tree selection will continue for the next few years, until enough are transplanted to the seed orchard to furnish an adequate supply of seed for the production of seedlings.

2. The Forestry Extension Department and the School of Forestry cooperated with the U. S. Forest Service in establishing a Fraser fir seed source on Roan Mountain in Mitchell County. "Superior" trees were selected and tagged by Dr. Bruce J. Zobel of the School of Forestry. All trees that were not selected were

cut and removed from the area. The remaining stand will be sprayed to control the balsam woolly aphid.

3. Assistance was given the American Pulpwood Association in organizing and conducting a three-day short course for pulpwood dealers and pulp and paper company field personnel. This course was given in Raleigh, North Carolina.

NORTH CAROLINA FOREST SERVICE
Service Foresters Soils-Economics Seminar

November 17 - 19, 1964
Kinston, N. C.

November 17

9:00	Soils of North Carolina
10:00	Soil Forming Factors
11:00 to 12:00	The Soil Horizon Color Texture Structure Consistence
1:00	Continuation of the Soil Horizon
2:00	Drainage and Aeration
3:00	Soil Reaction and Cation Exchange Capacity
4:00	Humus and Microorganisms

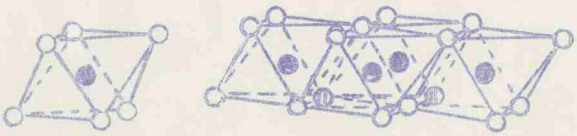
November 18

8:00	Soil Site Quality
9:00	Compound Interest in Forest Management
10:00	Classroom Problem
1:00 to 5:00	Field trip - Coastal Plain soils in Kinston area

November 19

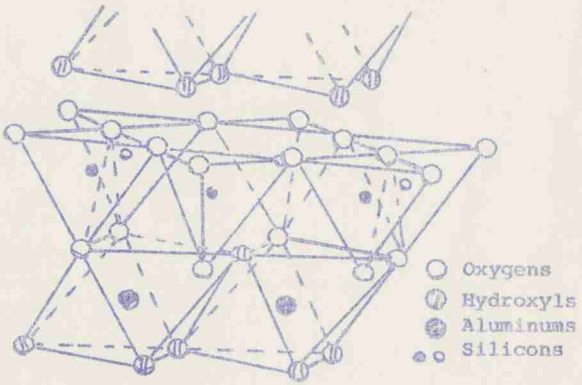
8:00 to 12:00	Field trip - Coastal Plain Soils in Kinston area
1:00 to 4:00	Field trip - Drainage methods and results on Hofmann Forest

Structure of the Clay Minerals



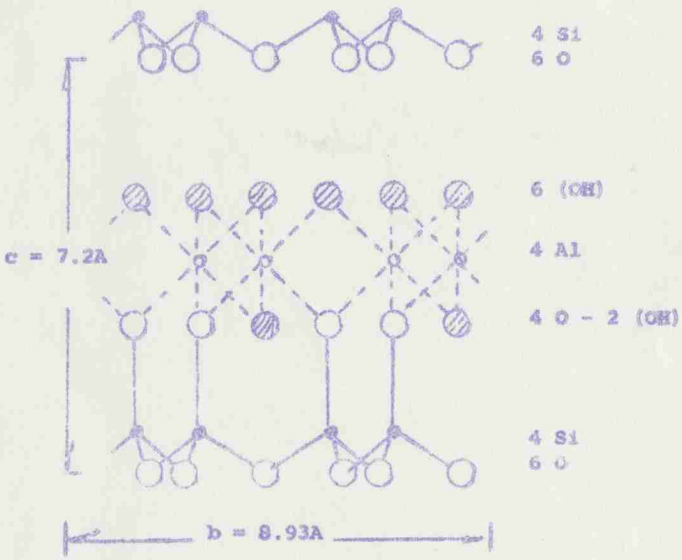
○ and ◍ = Hydroxyls ◉ Aluminums, magnesiums, etc.

Diagrammatic sketch showing (a) single octahedral unit and (b) the sheet structure of the octahedral units.



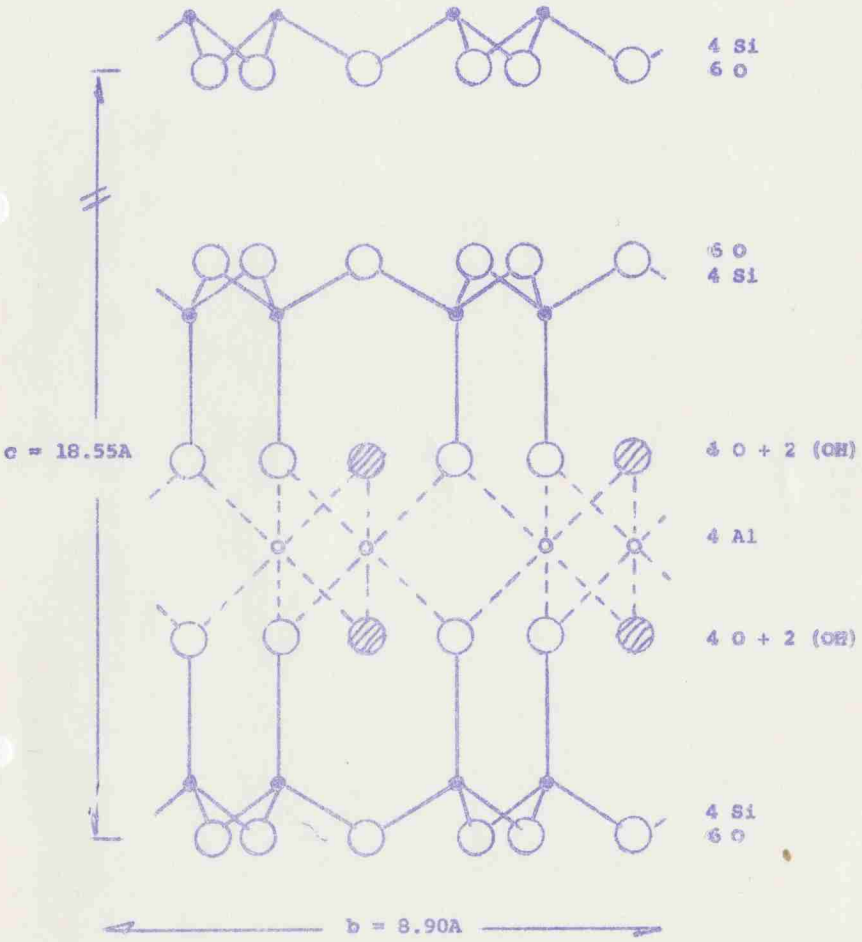
Diagrammatic sketch of the structure of the kaolinite layer, after Gruner.

Bond Structure



Kaolinite (after Gruner)

Bond Structures



Phrophyllite (after Pauling)

Base Exchange

The phenomenon of base exchange was first discovered by Way (1850) who percolated a solution of KCl through a soil and found that a differential adsorption takes place, the potassium being retained and another element, mostly calcium, coming into solution. The reaction may be expressed as:

$$\left[\text{Colloid}\right]^{-} \quad Ca^{++} + 2KCl \longrightarrow \begin{matrix} K^{+} \\ K^{+} \end{matrix} \left[\text{Colloid}\right]^{-} + CaCl_2$$

Acid soils under similar conditions exchange H ions for the K ion, and the reaction may be expressed as:

$$\left[\text{Colloid}\right]^{-} \quad H^{+} + KCl \longrightarrow K^{+} \left[\text{Colloid}\right]^{-} + HCl.$$

In the presence of water the colloidal particle, composed primarily of a complex mixture of iron, aluminum, silicon, oxygen and hydrogen, acts as a huge anion. This is called the colloidal micelle. The surface of a colloidal micelle carries negative charges of electricity because of the presence of electrons in excess of those necessary to satisfy the balance of positive charges and negative charges between the atoms and molecules within the particle. The colloidal micelle, then, can be visualized as a large complex anion with an atmosphere of negative electricity or electrons. They adsorb or hold all cations except the H^{+} ion by electrostatic attraction which involves the transfer (ionic transfer) or one or more electrons to the cation which through the process of ionization has lost one or more electrons to become an ion carrying one or more positive charges.

The strong adsorption of the H ion is attributed to the fact that it is the only cation that can form a co-valent bond with two shared electrons, whereas the other cations must be held by electrostatic attraction (electro-valency) which involves the complete transfer of electrons (Pugh 1934). Electro-valency is the type of linkage that occurs in KCl where Cl with 17 electrons takes up one electron from K with 19 giving them 18 electrons each, which is the same number as the very inert and stable arrangement found in argon. Co-valency is the type of ionic linkage that occurs in molecular chlorine or hydrogen. Two hydrogen atoms, each having only one electron, unite to form the hydrogen molecule (H_2) in hydrogen gas. Each atom shares its lone electron with the other to form the molecule with two electrons.

Exchangeability of Cations

The intensity of the force that holds cations at the surfaces of colloidal particles is a function of (1) the valence or positive charge of the cation, (2) the size (diameter) of the cation, (3) the degree of hydration of the cation, and (4) whether the ion is held by an electro-valent bond or a covalent bond as in the case of hydrogen.

The replacing or energy of replacement of the following cations are arranged in descending order:

$$H \gg Ca \gg Mg > NH_4 > K > Na > Li.$$

For example, potassium can replace more calcium in a soil than can sodium, and it will also be adsorbed by the soil to a greater extent.

In nature, soil colloids hold many cations at their surface among which the hydrogen ion is almost always present. If, for example, in the field the soil colloids are saturated with Ca^{++}, NH_4^+, and Na^+ ions, these ions would gradually be replaced by hydrogen ions formed from carbonic and other acids. In addition other constituents of litter such as the potassium and calcium released during decomposition move into the soil and become adsorbed by the colloidal particles, releasing cations already adsorbed. Further, the various cations released through the decomposition of primary soil minerals are constantly available for adsorption or release by the soil colloids.

Soils that have a high cation exchange capacity tend to maintain their fertility at a higher level than soils with a low exchange capacity. The former would hold by adsorption a greater quantity of Ca, K, and NH_4 if applied in fertilizers than the former. Such soils would be considered "strong" by farmers, the effects of fertilizer treatments being felt for a long time after application.

Mattson and Hester (1932) consider the soil colloidal complex to represent salts of weak acids (silicic and humic) and bases (aluminum and iron). Because of their weakness these acids and bases neutralize

each other only partially, leaving an acid and a basic residue too weak for a mutual interaction. If the acid residue is high the cation combining power is high and the anion combining power low, whereas if the basic residue is high the cation combining power is low and the anion combining power is relatively high.

Thus compounds of the former type might be represented by formula (1) and compounds of the latter type by formula (2) where A and B represent acid and basic groups respectively.

(1) H_2A … BOH … H_2A (2) Ha … $B(OH)_2$ … $B(OH)_2$

The type of colloid represented by formula (1) is developed in cool humid climates where podzol soils are formed. Under conditions of acid hydrolysis the basic components of the colloidal system become mobile and are moved out of the soil (or a part being precipitated in the B horizon). Such colloids tend to develop a composition which is stable at the prevailing pH (low). They have a high acidic residue and a high silica-sesquioxide ratio. They have a high cation exchange capacity because with their high acidic residue they are strongly electronegative. Conversely, formula (2) may represent the type of colloid developed under hot humid climates where lateritic soils are formed. Under conditions of alkaline hydrolysis the silica of the silicates becomes mobile and is removed, the resultant colloid has a high basic residue which tends to become stabilized under the

prevailing pH. Because of the small acidic residue it is only weakly electronegative and hence has a low cation exchange capacity.

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FIRST ANNUAL REPORT
Cooperative Industry- N. C. State
Hardwood Research Program

School of Forestry
North Carolina State
Raleigh

June, 1964

FIRST ANNUAL REPORT
COOPERATIVE INDUSTRY- N. C. STATE
HARDWOOD RESEARCH PROGRAM

INTRODUCTION

The cooperative Industry- N. C. State sponsored Hardwood Research Program, authorized in June, 1963, has now been in operation nearly a year. An interim progress report issued January, 1964, told of developments in organization, outlined the scope, listed major problems and prospective needs for inquiry, and made some specific proposals for conduct of research. This first annual report will deal somewhat more specifically with the nature and extent of major accomplishments since July 1, 1963, and includes some background considerations underlying current and proposed investigative work.

The major expenditure of effort has gone into the following activities:

1. Site quality evaluation, growth, and yield.
2. Silvicultural and management explorations, with emphasis on regeneration, site preparation, and related phases.
3. Tree improvement, provenance, and other problems associated with geographic and physiographic influences.
4. Wood variation of some key species.

An informal problem analysis at the start, although not of the searching intensity represented by Nelson's (1956) project analysis for Piedmont hardwood management, clearly suggested a dearth of information in all of the above areas, and the need for developing more precise knowledge before sound prescriptions can be made with confidence. Nelson assigned twenty major projects in seven priority classes. Among the top three priorities he listed (a) site index study, (b) comparative site indices among hardwoods and pines, (c) hardwood nursery and planting studies,

(d) tree improvement and hereditary variation, (e) natural regeneration of the more valuable species, and (f) timber stand improvement methodology. In effect, in our own informal evaluation, reflecting the views of industrial representatives as encountered in the field both in the Piedmont and the Coastal Plain, we are in remarkably close agreement with the prior thinking of Nelson (1956) in his Piedmont project analysis.

SITE QUALITY, GROWTH AND YIELD

Sweetgum.- Of all the hardwoods, sweetgum (Liquidambar styraciflua) has been singled out as the one species in which every cooperating industry has a deep and abiding interest. We have, therefore, undertaken site quality evaluation and yield study for this species from areas in Alabama northward to Virginia. The ubiquity with which this species becomes established on a variety of sites makes it important to determine under what site conditions it will produce acceptable yields of marketable material.

Some information regarding site quality of sweetgum is already available. In the Eastern and Western Shores of Maryland, Trenk (1929) classified sites for this species based on 59 plots into three quality categories as follows:

Quality I - Average height of dominants at 50 years equalled 90 feet. These sites were mainly limited to lowland abandoned fields of high fertility and moist soil.

Quality II- Average height of dominants at 50 years equalled 75 feet. These sites occurred on wet soils with little or no drainage, along rivers and stream course swamps.

Quality III- Average height of dominants at 50 years equalled 60 feet. These sites were found on well-drained uplands and well-drained meadows.

In the lower Piedmont, Ralston (1955) in his Master's thesis project at N. C. State found that topographic position alone could roughly be used for estimating site index by means of a simple regression equation in which arbitrary weights were assigned to topography, namely one for ridge, two for slope, three for lower slope, and four for bottomland sites. Based on 33 plots, he derived the equation:

$Y = 63.7 + 6.52 (P)$, where Y is the site index (i.e. height of dominant sweetgum at 50 years) and P is topographic position. The actual mean site indices and their standard errors in feet at 50 years were as follows:

Ridge	70.2 ± 5.2
Upper slope	76.7 ± 2.7
Lower slope	83.3 ± 2.5
Bottom	89.8 ± 3.3

It is evident from the above that somewhat greater variability was encountered on the ridges where occasionally sweetgum will attain quite respectable development.

In the Coastal Plain of New Jersey, Phillips and Markley (1963) found several methods of estimating sweetgum site index from soil and watertable characteristics and their final equation was a multiple regression involving seven variables. On mature soils the site indices ranged from about 50 feet to about 90 feet, with the best sites having between 40 and 50 percent fine sands and about 55 percent clay in the B_2 horizon.

In the Mississippi Delta region Broadfoot and Krinard (1959) also developed several measures of estimating sweetgum site index. One method employed two variables, (a) the clay percentage at a depth of approximately three and one-half feet and (b) the exchangeable potassium, in lbs. per acre of the soil at that depth. Their site index values ranged from about 70

feet to about 120 feet, the highest values being encountered where clay content was only about five percent (where the entire range extended from 5% to 80%) in combination with 550 lb. of exchangeable potassium per acre (the range in K being from 0 to 550 lb/A).

It is fairly evident from past studies that within the commercial range of sweetgum several different factors may have an important effect on growth performance of this species, but in most instances the textural properties of the subsoil, the degree of drainage, and topography are likely to have a strong influence. Our own observations up to this stage is that in bottomlands with clay loam and silty clay loam surface soils, degree of internal drainage may have a strong influence. Chemical characteristics may also have a substantial bearing as is suggested in the investigations of Broadfoot and Krinard (1959). Finally, latitude undoubtedly plays a role, and it may be possible to assess how important it is when we have obtained sufficient samples from Alabama to Virginia.

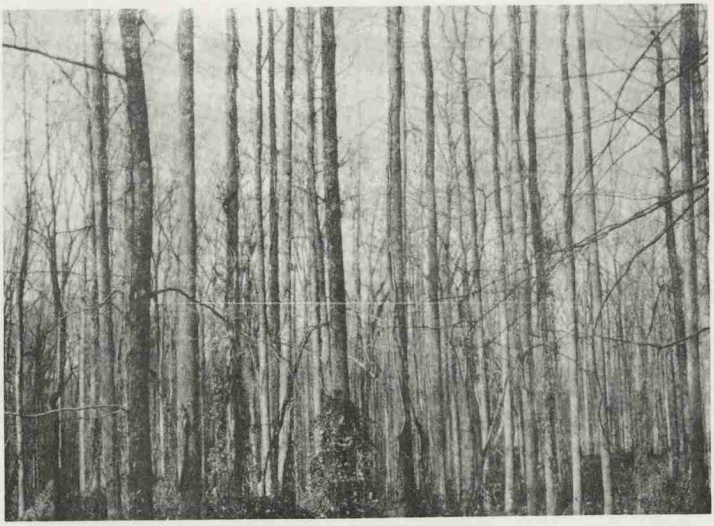
To date there is less information on actual yields of sweetgum than there is on site indices, per se. Nearly thirty years ago Winters and Osborne (1935) determined yields of sweetgum on alluvial lands in the deep South, and their data suggest the tremendous potential of this species for fully stocked stands on good sites. Perhaps the earlier data of Trenk (1929) in Maryland represents more nearly the average performance of this species on sites representative of much of the industry-owned land. It may be of interest to list here what Trenk felt as representative of poor and good performance of sweetgum over an age range of 30 years.

	Site Quality POOR SI-60' AGE-YEARS				GOOD SI-90' AGE-YEARS			
	20	30	40	50	20	30	40	50
Avg. Ht. of Dominants-ft.	37	46	54	60	56	69	81	90
Avg. dbh of stand	2.5	3.4	4.7	5.7	4.0	5.5	7.5	9.1
Trees per acre	2,450	1,670	1,070	760	1,150	780	495	355
Basal Area/Acre-ft.^{2}	81	108	127	132	99	130	152	161
Peeled volume-ft.^{3}	845	1,590	2,310	2,840	1,600	3,000	4,400	5,400

For New Jersey old-field stands Phillips has developed a prediction equation for yield of rough wood involving product-moment interactions of site index, age, and basal area. The equation is as follows:

Yield (in ft.^{3} of roughwood) = $580 + 0.813 \sqrt{(SI)^2 \times Age \times B.A.} \times 10^{-4}$; the error of estimate was $\pm$ 385 ft.^{3}, and the correlation coefficient 0.968 indicating that some ninety-three percent of the variation was accounted for by the variables employed in the prediction.

Direct comparison of Phillips' old-field data with those of Trenk for Maryland from both old fields and other situations is not feasible without adjustment, since the latter were in the form of peeled volumes, but it may still be worthwhile to look at the magnitude of discrepance among the values at selected points of their respective data.



Sweetgum before (upper) and after (lower) thinning for stand improvement. Growth response and degree of "water sprouting" are being followed on individual trees and stands subjected to thinning. Volume removed amounted to 4 M. bd. ft. and 10 cords of pulpwood per acre. Remaining volume is 12 M. bd. ft. per acre.

	SI-60		SI-90	
	Trenk	Phillips	Trenk	Phillips
Basal Area*				
30 yrs.	108	135	130	175
40 yrs.	127	150	152	185
50 yrs.	132	160	161	195
Volume-ft.3**				
30 yrs.	1,590	1,765	3,000	4,040
40 yrs.	2,310	2,335	4,400	5,455
50 yrs.	2,840	2,925	5,400	7,000

* Trenk's values include stems 3 inches, dbh, and up; Phillips', 1.5" dbh and up.

** Trenk's values are peeled volumes; Phillips' are rough wood.

Phillips warns that use of his equations and tables "outside of the population described ----- is risky, and should not be undertaken lightly. Neither should cause and effect be read into these relationships -----." The main point here is that a substantial amount of additional data and many analyses are required to strengthen the existing information on the growth and yield of this important species which occurs over such a wide geographic range and on such a variety of soils and sites.

Accordingly, we have undertaken preliminary sampling of sweetgum stands with the expectation of greatly stepping up data collection during the coming year. Tentatively, and ultimately, we hope to secure data from approximately 150 stands in each of the two major physiographic provinces. Height, diameter, density, composition, and related characteristics of the stand, plus physical and chemical data of soils will constitute the elements to be examined for developing site quality evaluation and growth and yield prediction.

A selectively marked stand of tupelo before and after logging. The upper picture shows the stand prior to logging, the lower one after removal of 11 M. bd. ft. of sawtimber and 3 cords of pulpwood per acre.

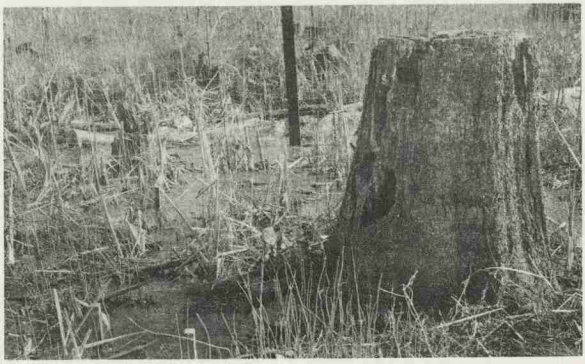
SILVICULTURE, MANAGEMENT, AND RELATED INVESTIGATIONS.

Timber stand improvement. The main activity here has included some follow-up work on (a) plot data and plots established in 1962 and 1963 by Ed Jones and John Putnam in the Roanoke River bottom holdings of Riverside and Georgia Pacific, and (b) laying out of some TSI plots in mixed hardwoods on Georgia Pacific holdings in the Cohen's Bluff area of the Savannah River, and on Williams Furniture Company land in South Carolina.

Response to release and weeding is being followed in the sweetgum stands on Riverside lands near Pollock's Ferry, and in mixed hardwoods of Georgia Pacific's Hussey Tract near Woodville. On the latter tract individual tree response is being followed using dendrometer bands. The purpose of these studies is to determine variation among species and trees in annual resumption of growth in such species as cherrybark oak, red maple, green ash and sweetgum. At the same time, we are determining degrade from development of epicormic branches that may be stimulated by release. For example, in one plot on a mixed stand where the basal area before TSI was approximately 110 ft^2/acre and after release and weeding was down to about 60 ft^2/acre, one season after treatment, one-third of the sweetgum crop trees had no epicormic branches in the butt log, but one-sixth of the total had from ten to fifty "water-sprouts" in the butt section. Even allowing for individual differences in degree of release, there appears to be an inherent factor that controls the development of either adventitious or dormant shoots when stimulation in the form of sudden release is applied.

The evaluation of response to release, and in this connection of volume and growth estimates, particularly in tupelo-cypress types, has emphasized the need for developing meaningful mensurational data. Stand tallies for tupelo show basal areas exceeding 500 $ft.^2$ per acre, even though diameters

Dendrometer band used in measuring time of initiation and amount of growth on individual trees. This band allows reading of circumference growth to the nearest 0.01 inch.



Exclosures built to exclude deer in the Roanoke River Regeneration Study. Upper-an ash plot at the time exclosure was being installed. Middle-completed tupelo exclosure. Lower- interior of tupelo exclosure showing milacre plot corners. Note the ten-foot double-strand height of the wire.

Nine such exclosures have been constructed, this work being completed in January, 1964. The exclosures are in three types, --tupelo-cypress, ash flat, and sweetgum terrace, and are replicated three times, i.e. one set of three exclosures at Pollock's Ferry, one on the Hussey Tract, and a third set on True Temper lands on the north bank of the Roanoke below Williamston. A total of one-hundred-eighty-nine plots are under observation, of which eighty-one are within the exclosures, hence safe from deer browsing, and 108 plots are outside the fences. Initial results will be summarized in the winter of 1965 by Mr. Bratamihardja, a graduate student working for the Master of Science degree at N. C. State. It is expected that this study will supply much additional information on bottomland hardwood regeneration, so it is planned to follow the developments in and out of the exclosures for several years.

One facet of natural regeneration has involved examination of sweetgum establishment after fire. Old fields generally seed in, but relatively few sweetgums that appear after a fire on forest soils are of seedling origin. Regeneration of sweetgum from root suckers and stump sprouts has been observed in the past in a number of instances and in a general way, but precise data on this point are lacking.

To obtain actual data of the extent of root sucker and sprout regeneration of sweetgum, we surveyed a stand of young sweetgum known to have been established after a hot burn in a pine stand located near the Lowes Grove School on N. C. Highway No. 54 in Durham County, North Carolina. The stand on one side of the road was logged six years ago, and the other side was comprised of a dense sapling stand 15 to 20 feet high with 2,000 to 3,000 stems per acre. A very hot wild fire burned through stands on March 25, 1959, killing the entire sapling stand, and all but a few mature pine stems in the residual cut-over portion.

Natural Green Ash reproduction after clearing with a K-G blade in 1962. Two years after site preparation, up to 400,000 seedlings per acre had become established in spots. Upper- general view of the prepared site with deer exclosure in background; lower- close-up of established seedlings.

Examination of 80 milacre-quadrats on transects through both the sapling and cut-over areas in January, 1964, showed sweetgum to be established on 74% of the quadrats. Every plant examined was of root sucker or stump sprout origin. On the stocked quadrats, numbers of sweetgum stems ranged from 1,000 to 17,000 per acre. In quadrats stocked with sweetgum, this species was in a dominant, free-growing position on 74% of the quadrats; on the remainder, other species such as loblolly pine, persimmon, red maple, oak, and blackgum were dominant. Thus, species other than sweetgum were established on 24% of the quadrats, leaving only 2% of the total area with less than one tree per milacre, or 1,000 trees per acre.

Height of the sweetgum regeneration ranged from two to eleven feet, other species ranging from one to twelve feet. The soil is mainly a clay loam, adequately drained, and with a relatively shallow surface horizon typical of much Piedmont land that has been adandoned by agriculture in the past.

In this instance regeneration of sweetgum by sprouts and root suckers, mainly the latter, following fire has resulted in sufficient stocking to provide an adequate stand for the next rotation. As we accumulate more evidence we expect to substantiate that fire can serve as a useful silvicultural tool in sweetgum regeneration on cut-over land. Root suckers, particularly, appear to be satisfactory propagules, initiating underground and being in this respect equivalent to seedlings except for exhibiting faster growth. Two or three tests are being installed to prove this practice of regeneration further, and these should provide the necessary working prescriptions.

Artificial regeneration. Both nursery practice and planting and seeding of hardwoods species are being evaluated and explored.

Nursery. Techniques for growing hardy dependable planting stock are being

developed in the Riegel Paper Corporation and Continental Can Company nurseries. Seed of blackgum, tupelo, sweetgum, sycamore, maple, and six oak species have been sown this spring, in the expectation of having planting stock of these species available for tests in the winter of 1964-65. Seed storage, stratification media, duration of stratification, and related phases of seed handling have been included in preliminary tests, and approximately 2500 lineal feet of nursery bed area have been sown in nurseries of Riegel and Continental Can. Additionally, methods for producing tupelo seedlings under varying water regimes, with later evaluation of tupelo seedling size and quality, are installed in the Kimberly-Clark nursery.

Planting and Seeding. Several planting studies have been installed during the past winter and spring.

a. Albemarle Paper Manufacturing Company has installed tests on sweetgum involving both spacing and seedling size. Spacings vary from about 25 ft.^{2} per tree to about 81 ft.^{2} per tree, both in square and rectangular patterns. These plantings are established in the isolation strips of their pine seed orchards where they will receive maximum care, and be readily available for subsequent trials on fertilizing, thinning, and the like.

b. In cooperation with Albemarle, we have established small tests of tupelo gum on deep organic soils and organic loams on the Hofmann Forest. These tests will involve subsequent evaluation of soil amendments on growth of this species.

c. A test of three pine species in comparison with sweetgum, tupelo, and yellowpoplar has been installed on upland soil on our Schenck Forest.

The Schenck test involves also evaluation of the effect of logging slash burns on the survival and initial growth of the six species. Our studies on comparison of yellowpoplar and loblolly pine in Durham County during the past

Seedbeds in the Riegel Nursery planted in hardwoods. Sweetgum, tupelo, blackgum, sycamore, and five oak species were sown in April. Additional hardwoods have been planted in the Continental Can and Kimberly-Clark Nurseries.

ten years has indicated that over a nominal range of site qualities, the common regression of annual increment on age from the second up to the tenth years is essentially linear and can be roughly expressed by the following equations (Lin, 1963):

For yellow-poplar:

CAI in height= 0.365 + 0.175 (Age)

For loblolly pine:

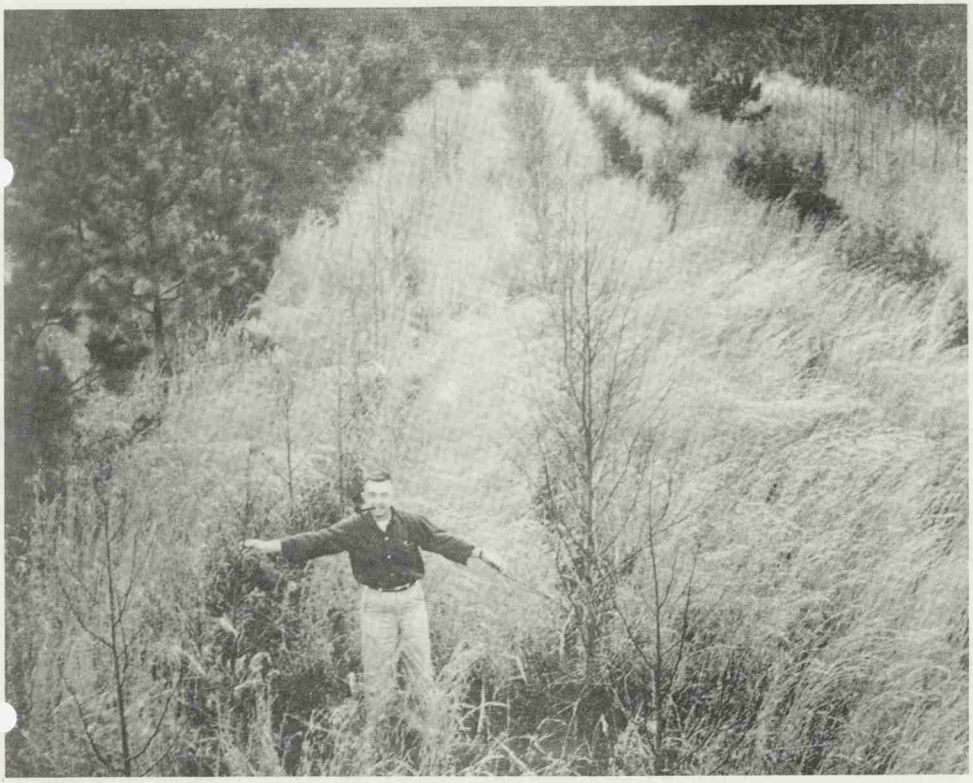
CAI in height= 0.389 + 0.484 (Age), where age is in years, and the current annual increment (CAI) is expressed in feet.

Note that the current growth of loblolly on ordinary upland forest soils exceeds that of yellowpoplar by more than 2 to 1; however, on local spots (microsites) of the same soil where burning of logging slash and related debris has greatly altered the character of the surface soil and reduced initial competition from lesser vegetation to almost zero, the regression coefficient for yellowpoplar equals or exceeds that for loblolly pine. It is believed that sweetgum and tupelo, as well as many other hardwoods will follow the same pattern.

d. Preliminary tests of both planting and seeding on a small scale on sweetgum and tupelo have been undertaken in natural sweetgum and tupelo swamp sites, respectively, on Riverside and Georgia Pacific operations on the Roanoke River. These tests will afford initial comparisons of artifically started versus natural regeneration of these species.

e. A test of grades of tupelo stock has been installed by Weyerhaeuser Company in Beaufort County. This test should yield preliminary information on the influence of morphological grades on the establishment of this species about which experience is minimal.

f. Graded tupelo seedlings have also been outplanted by Kimberly-Clark



Fertilized and unfertilized rows of sweetgum planted in the North Carolina Coastal Plain. The row on the left is unfertilized. The row on the right was fertilized with a balanced soil amendment at the time of planting three years ago.

to estimate survival and growth by seedling quality. These plantings have been made in drained beaver ponds in an attempt to find a species which is not extensively worked by beaver. Rumors persist that tupelo is low on the palatability list of this animal so notorious for gourmandism. If this speculation proves correct, establishment of tupelo in beaver areas will return several hundred acres of land to production of desirable species.

g. Tests for which plans have been completed, or are being prepared include:

(1) Determination of regeneration and growth of several hardwood species both in drained and undrained portions of the Green Swamp. Both 1-0 seedlings and direct seeding of seven hardwood species will be tested against performance of loblolly pine. Some exploration with additions of minerals and soil amendments will also be included in this study which will be installed on drained and undrained flatlands, and hardwood bottoms to provide information on practicability of artificial regeneration of hardwoods on Coastal Plain peat and muck.

(2) Plans for test of species-site relationships with comparisons against pine performance are also underway for Piedmont uplands of Riegel, Continental Can, and Kimberly-Clark, to assess the influence of topography and soil from stream bottoms to ridge tops. Similar studies will be installed on Williams Furniture Company and Weyerhaeuser lands in the Coastal Plain.

TREE IMPROVEMENT, PROVENANCE, AND RELATED INVESTIGATIONS.

Provenance.

(a) Sweetgum. Delineation of collection zones of sweetgum seed for planting and seeding has been initiated. Adequate quantities of seed from a minimum of ten individual trees will be collected from the operating territory

of each company in the program, effectively sampling the range of sweetgum in the Southeast. Test plantations of all seed sources will be installed in each operating area to compare growth of the local seed with all other sources within each locality. This test will also include comparisons of survival, growth, and yield of sweetgum with loblolly pine on the better sites. Seed for this study will be collected in the fall of 1964 and seedlings produced for field installation in the fall of 1965.

(b) Red maple. A maple provenance study involving seed collections from Coastal Plain sources growing on both mineral and organic soils is being installed by Weyerhaeuser. Results will determine the feasibility of establishing maple seed orchards for Weyerhaeuser using selections from both soil types. If these edaphic sources prove to be distinctly different it will be necessary to establish separate orchards. Seed for the study was collected this spring and planted in the Riegel nursery, with outplantings scheduled for the winter of 1964-65.

Seed collections for the study are being kept separate by individual trees. Such separation during collection, in the nursery, and in outplanting will demonstrate variability among individual trees in one-parent progeny tests and provide data for parent-progeny correlations.

Seed orchards. Establishment of hardwood seed orchards in yellowpoplar, sweetgum, tupelo gum, and red maple have been started by Weyerhaeuser. Selections have been made in all of these species and some truly fine individuals have been found. Asexual reproduction by grafting has been initiated for yellowpoplar and sweetgum. Currently tests are underway in the School of Forestry greenhouses to determine the feasibility of reproducing maple and tupelo by rooting to obtain material for these orchards. Plans are in the formative state to install seed orchards also for cherrybark and willow oak. To date,

39 sweetgum, 38 yellowpoplar, 11 red maple, and 3 tupelo trees have been graded. Additional selections for orchard use will be made this fall.

Arboreta. A small arboretum of hardwood species, both native and exotic, is planned by Williams Furniture Corporation. This installation is not intended as a species trial, but merely will bring together a few plants of all commercial hardwoods which are expected to live in this region. Such an area will demonstrate the performance of exotic hardwoods in this locality as well as bring together the various local species in one place. Seedlings of several native hardwoods will be planted this fall and seed of commercial "exotic" hardwoods have been requested from other localities. We plan to incorporate plants of several European species into the arboretum next year.

WOOD VARIATION

Wood variation studies were initiated at the beginning of the year on species considered silviculturally the most important. Excepting sweetgum, the major emphasis in the wood studies has been on tupelo gum, swamp black gum, willow oak, and water oak. Exploratory work has been done on southern red oak and sycamore. More recently, laboratory analyses have been extended to include wood of red maples selected for possible use in Weyerhaeuser's seed orchard.

Sweetgum, the species of greatest interest to cooperators has not been emphasized this first year because of Charles Webb's existing large study in variation of wood properties of this species for his PhD dissertation. Webb's results can serve as the foundation for our future work. We plan to supplement his prior work as needed to fill gaps in those areas of greatest concern to cooperators. Webb has established definite trends in variation of specific gravity, fiber length, and amount of interlocked grain; his

dissertation will be published soon.

Without going into details of Webb's findings, it is evident that specific gravity is lowest near the pith and increases rapidly to age 10-15 where it levels off and remains more or less constant. No significant differences were found between geographic areas sampled from Virginia to Florida nor between upland and lowland sites. Highly significant differences were found between trees in any one stand and between stands in one geographic area.

Fibers were shortest nearest the pith and increased in length with years from pith up to age 45, the limit of the sample trees. Unlike specific gravity, significant differences in fiber length were found between geographic areas. Large differences are evident between trees within a stand.

No correlations were found between growth rate and either specific gravity or fiber length. Interlocked grain, however, was correlated with growth rate, the faster growing trees tending to have a larger amount of interlocked grain.

Results of Fred Taylor's doctoral research on variation of wood properties of yellowpoplar will be available within the near future as a PhD dissertation. A portion of his data on fiber length variation within the tree was published in the October, 1963, issue of TAPPI.

Our studies in tupelo, black gum, willow oak and water oak have thus far analyzed specific gravity and fiber length variation in one or two stands per species. These studies will be expanded with time to determine geographic as well as within tree and within stand variation.

Preliminary analysis of blackgum and tupelo from Brunswick County in the North Carolina Coastal Plain provide rough comparison of the wood properties of these two species:

Species	Tupelo	Blackgum
Age	50+	50+
DBH	9.9"	10.5"
Ht. (Dom.)	59'	55'
Sp. G. (1st 10 rings)[1]	.45	.49
Range	.41-.52	.38-.56
Weighted Sp. G.[2]	.48	.52
Range	.47-.52	.46-.61
Avg. Fiber Length (10 yr.) mm.	1.81	1.78
Avg. Fiber Length (30 yr.) mm.	2.02	1.93
Avg. Fiber Length (50 yr.) mm.	2.02	2.05
No. Trees	10	25

[1]Dry Wt. - Green volume basis. Two samples analyzed at DBH in blackgum, above butt swell in tupelo.

[2]Each 10 yr. segment of the cross section weighted for the area it represents.

Specific gravity of tupelo appears lower than blackgum and the range of variation is smaller when considering the first 10 rings. The same is true for the trees sampled when the weighted specific gravity is considered. Fiber lengths of the sampled trees appear to be about the same for the two species, the difference being less than 0.1 mm. at any given age. Since our data has not been subjected to statistical analyses, and represents a limited population, any observed differences should be regarded as indicative, not conclusive evidence of real values.

Data will be analyzed statistically for variation in these two characteristics not only from DBH samples but up the bole of the sample trees. As

we obtain the same type data for other areas, we can then establish the broader variation patterns in specific gravity and fiber length.

Similar contrasts are possible between water and willow oak in Brunswick County, North Carolina. The trees of the two species were all growing within one stand.

Species	Willow oak	Water oak
Age	40	40
DBH	11.1	9.3
Ht. (Dom.)	49	46
Sp. G. (1st 10 rings)	.58	.60
Range	.53-.63	.58-.63
Weighted Sp. G.	.57	.60
Range	.52-.61	.57-.64
Avg. Fiber Length (10 yrs.) mm.	1.44	1.60
Avg. Fiber Length (30 yrs.)mm.	1.37	1.49
No. Trees	10	10

Specific gravity of water oak was approximately .02 higher than willow oak and the water oak fibers average approximately 0.1 mm. longer than willow oak. More extensive sampling of these species are being made to evaluate within tree, between tree, and geographic variation. Again, we emphasize that the wood property values shown and comparisons made between species are but preliminary indications.

Less intensive sampling of sycamore and red maple from the North Carolina Coastal Plain are included to indicate the approximate ranges existing in these species for the characteristics being studied:

Species	Sycamore	Red Maple
Sp. G. (1st 10 yrs.)	.43	---------
Sp. G. (weighted)	.45	.50 (sapwood)
10 yr. Fiber Length mm.	1.71	1.01
Range	1.57-1.83	.91-1.18
30 yr. Fiber Length mm.	1.80	1.06
Range	1.49-2.16	.94-1.19
No. Trees	6	11

These samples show sycamore and maple to have approximately the same specific gravity in the North Carolina Coastal Plain as the tupelo and black-gum. The sycamore fiber lengths appear to be slightly shorter than the gums and the maple fibers are much shorter but the sample includes only a few trees.

PERSONNEL

Personnel directly assigned to the program include R. L. McElwee and E. M. Jones, Director and Associate Director, respectively, and Mrs. Judith Faircloth who has the dual role of laboratory technician and secretary.

Bob McElwee shifted to the hardwood program after having served as Liaison Geneticist on the Tree Improvement Program since its inception in 1956. Ed. Jones, starting with the Extension Forestry Division in 1951, more recently served as Hardwood Specialist for them after doing graduate work in Bottomland Hardwood Management.

Dr. T. E. Maki, as head of the Department of Forest Management under which the Hardwood Research Program operates serves as coordinator and advises on aspects of the program as needed.

Mr. Richard Usanis, graduate student in Forest Management, helps in preparation of laboratory samples of wood specimens, and assists in collection of field data. Mr. Usanis, a Syracuse graduate, is working on the hybridization between willow and water oaks for his research problem.

Mr. M. Bratamihardja, here on a University of Kentucky scholarship, has a thesis problem on natural regeneration of hardwoods, and Mr. S. Terzi, AID Scholarship student, has a Master of Science thesis problem involving hardwood seedlings following planting.

FINANCES

Funds for the Hardwood Research Program are derived from industry contributions and the Agricultural Experiment Station including McIntire-Stennis funds. Industry contributions provide the major source of program finances. A portion of the salaries are paid with experiment station funds. McIntire-Stennis funds provide partial salary and supply support for the wood variation studies in tupelo gum.

The following organizations, participants in the Hardwood Research Program, provide the major source of financial support:

Albemarle Paper Company	Roanoke Rapids, N. C.
Champion Papers, Incorporated	Canton, N. C.
Continental Can Company	Savannah, Georgia
Georgia Pacific Corporation	Augusta, Georgia
International Paper Company	Georgetown, South Carolina
Kimberly-Clark Corporation (Coosa Division)	Coosa Pines, Alabama
Planters Manufacturing Company	Portsmouth, Virginia
Riegel Paper Corporation	Bolton, N. C.
Weyerhaeuser Company (N. C. Division)	Plymouth, N. C.
Williams Furniture Corporation	Sumter, South Carolina

Their support, both financial and the provision of lands, labor, and equipment to the field phases of the program have made this cooperative approach to hardwood research possible. Their confidence in the program, demonstrated by this support, is gratefully acknowledged.

SYSTEMS ANALYSIS IN TREE HARVESTING OPERATION

The Purpose of the Study

The immediate purpose of this study is to develop valid data on the cost of producing multiple length pulpwood and at the same time compare the relative costs and efficiencies of producing pulpwood using Montague mill, a strictly multiple-length or long-wood operation, and an integrated operation producing both long wood and sawlogs.

Pulp companies in the South, at present, are securing pulpwood from producers primarily using one or the other of the following seven methods:

1. Montague mill
2. Long wood
3. Integrated sawlog and long wood
4. Tree length skidding and bucking at the deck
5. Integrated sawlogs and 5' bolts
6. Short wood-pallet operations
7. Short wood-bobtail operations

The data collected in this study may be used in the future as a portion of other studies to:

1. Determine the cost of producing pulpwood by each of the systems.
2. Determine the minimum size tract feasible for each operation.
3. Determine optimum skidding distance for each type of operation.
4. Determine how to balance an individual system to minimize the cost of that system.

The method of collecting the data

For simplicity, the three operations have been reduced to eight major cost centers. Each of these can be easily defined and isolated on the ground.

The cost centers are:

1. Transporting labor to and from the woods
2. Felling (including ringing, brushing, stumping, & limbing)
3. Skidding to deck
4. Bucking at deck
5. Loading
6. Hauling
7. Trucking
8. Bucking at the yard

These operations are to be observed by three men who will time the various functions involved in each operation and perform the primary analysis of the data obtained.

These observers should devote at least one day of the study period to familiarizing themselves with the operation and develop flow charts describing each operation.

Forms will be issued which should be used in collecting the data. These are designed so as to allow the data from each of the operations to be directly comparable and still adeuqately describe the entire operation.

Any modification which the observers find to increase the utility of the forms will be welcomed as long as it does not destroy the function of comparability. Table 1 at the end of this paper is a list describing the functions within each system to be isolated in the study and the coefficients to be derived.

Prior to the study the areas will be cruised by pulp company and the common cruise data will be presented in the form of a stand table showing grade of trees and DBH. In addition, the cruises should report the form class of the species on the tract and the diameter at stump height for each D.B.H. class.

The collection of data

In outlining the operation, while constructing the flow charts, the observer should record the size of the crew, the make, model, year, and condition of equipment, and the deployment of the equipment on the operation. Any change in these during the course of the study should be noted in the final analysis.

In addition, a note should be made each day on factors pertinent to the operation, such as weather, soil conditions, any equipment breakdowns which might bottleneck activity, injuries, etc.

Form #1

Date_____ Driver_____

TRIP TICKET FOR GPV

Time at start_____ Miles at start_____
Number of stops_____
Time arrived at woods_____ Mileage_____
Time arrived home_____ Mileage_____

Other trips during day
Reason_____ Mileage at end of trip_____
_____ _____
_____ _____

Gas_____
Oil_____
Repairs_____

Labor Transportation

This form should be completed by the driver of the GPV (General Purpose Vehicle) and handed to the observer at the end of each week.

The object is to determine how much time is consumed each day in transporting the crew to and from the woods and the expense involved in this operation, and also to determine how often the GPV is used for other trips.

The forms should be given to the driver of the truck and his cooperation requested. The times required can be taken from the driver's watch - extreme accuracy is not necessary. The mileage can be read from the odometer.

For the other trips the vehicle may make in the course of the working day, all that is required is the reason for the trip and the mileage at the end. The trip miles can then be determined by subtraction.

The driver should also keep a record of the quantity of gas and oil added, and report the nature of any repairs.

From #2

Operation_____
Time Obs. Started_____
Time Obs. Stopped_____

Date_____
Time_____
Weather_____
Stand condition_____
Observer_____

FELLING

Tree #	D.B.H. (Inches)	Walking		Time				Remarks
		Time (Min)	Distance (Feet)	Decision	Severance (Minutes)	Limbing	Delay	

Felling

The date, approximate time of day, the weather conditions, stand condition, and the observer's name and type of operations should be recorded at the beginning of the timing. Weather conditions can be classified as sunny, cloudy, humid, and the temperature given, etc. If any significant change (i.e., starts raining) occurs during the timing, it should be noted and the place on the sheet where this occurred also noted. Stand condition refers mainly to ground cover (APA classification), but any other factors which may be pertinent to the analysis should be noted. When more than one form is used at any timing, this information need only be given on the first form and the rest attached to it.

The tree # is recorded mainly for the observer's convenience. In some instances, the feller may drop several trees before limbing any, and this helps the observer to place the information when the feller returns to complete the operations on these trees.

The D.B.H. should be recorded in 2-inch diameter classes.

Decision time is to include the time the operator spends deciding where to drop the tree and preparing (brushing, etc.) to fell it. Decision time ceases when severance time begins.

Severance time begins when the feller touches the saw to the tree and continues until the tree is on the ground. If any lodging occurs, the felling time stops when the tree stops falling; and the time spent dislodging the tree is classified as delay and the cause noted. If the dislodging does not involve any delay (as in the case of dropping another tree which was to be cut on it), the operation is recorded in the usual manner.

Limbing time includes the time the operators spends walking from the stump to the top, cutting off the limbs and severing the top. Limbing time stops when the operator leaves the top and starts moving to the next tree.

Any and all delays which occur should be timed and the cause recorded. For purposes of analysis it may be helpful to classify the delays into two groups - (1) natural delay - feller lights a cigarette, takes a short break, files saw, refuels it, and (2) unnatural delay - saw will not start, waiting for skidding or ringing equipment, lodged tree, etc.

Form #3

Date_____
Time_____
Weather_____
Stand condition_____
Observer_____

Operation_____
Time Obs. Started_____
Time Obs. Stopped_____
Location_____

SKIDDING - OBS. IN WOODS AND AT DECK

Trip #	D.B.H. (inches)	Length (Feet)	Hook or unhook time (Minutes)	One-way Distance (Feet)	Round trip time (Minutes)	Delay (Minutes)	Remarks

From #3 is to be used for recording at two locations - in the woods and on the landing. These measurements can be taken while observing other operations, and for this reason the elasticity has been included.

When working in the woods, the section of the heading of the fourth column reading "hook time" should be circled; and when at the landing, the "unhook time" section should be circled.

The trip number should be recorded next to the first entry for each trip. The D.B.H. and length should be noted for each log in the trip.

On form 3, the choker setting and hook up time begins when the tractor driver gets off the tractor to play his cable out to reach the first log and stops when that log is drawn up to the tractor.

When the last log of the bunch is drawn up to the tractor, the next entry in this column should be the time spent chocking and picking up the bunch. This entry should be circled to designate it at the time the analysis is being made.

The distance column opposite the bunching hook times can be used to indicate the effect of directional felling on the bunching time. To indicate the position of the tree in relation to the skid trails short lines in this column will be used.

A vertical line indicates a tree felled perpendicular to the skid trail (an angle between 45° and 135°, and a horizontal line indicates a tree felled approximately parallel (an angle between 0° and 45° or 135° and 180°).

From #4

Date_____
Time_____
Weather_____
Stand condition_____
Observer_____

Operation_____
Location_____
Time Obs. Started_____
Time Obs. Stopped_____

Form 4 (For Long Wood and Integrated)

Diameter of Cut	Time/Cut	Interval of Time Between Cuts	Delay	Remarks
(Inches)	(Minutes)	(Minutes)		

Form 4-1 BUCKING (MONTAGUE MILL)

Tree #	D.B.H.	Feed Time	Number of bolts	Bucking Time	Delay	Remarks
	(Inches)	(Min)		(Minutes)	(Min.)	

Bucking

Form #4 is to be used for the long wood and integrated operations, and From 4 is to be used for the Montague mill.

The same information at the beginning is required on these forms as on Form 1.

The Form 4 is to be used when timing bucking on the landing for the integrated and long wood operations. The major objective here is to determine the time consumed in making cuts of various depth and the average interval between cuts.

The diameter of the stick at the point where the cut is to be made should be estimated or measured and recorded.

The time elapsing from when the saw first touches the stick until the cut is completed, or the saw is removed from the cut should be recorded in the Time/Cut column.

The interval between cuts is the time elapsing from when the saw leaves one cut until it enters the next.

Delay and Remarks are handled in the same manner as on the other operations.

On Form 4-1, the information is the same up to the D.B.H. entry. On this form the next entry is feed time, which is time spent picking a stick from the deck and getting it aligned on the mill.

The bucking time begins as the stick begins to move through the mill and stops when the last bolt leaves the conveyor. The number of bolts per stick is also recorded.

The delay and remarks columns are completed in the same fashion as on the other forms.

Form #5

Loader (Longwood and Integrated)

Load #	Diameter at small end (Inches)	Time: Cold deck (Minutes)	Time: Truck (Minutes)	Delay (Minutes)	Remarks

Form #5 is to be used when timing the loading operation for the integrated and longwood operations.

In these operations, the loader may be operating in one of several ways:

1. It may be loading the material as it lies on the deck on both the log and the pulpwood truck.
2. It may be used for partially sorting the material on the deck (i.e., the tong setter may select a run of sawlogs and then a run of longwood).
3. It may be used to load either the longwood or the sawlog truck and be cold-decking the other material.
4. It may be used in cold-decking both sawlogs and longwood when no trucks are available.

These patterns of use will, most likely, change from time to time during the operating day. Any change in procedure should be noted in the remarks column opposite the stick on which it occurred.

The over-all elapsed time per load should be recorded on each page. This can be read either from a standard watch or from a stop watch. This can be recorded in the load number column directly beneath the load number.

The time column is divided into two sections, one for cold-decking and one for loading directly on the truck.

SYSTEMS ANALYSIS IN TREE HARVESTING

Form #6
Date _____
Weather _____
Observer _____

Operation _____
Location _____
Time observation started _____
Time observation stopped _____

Warm-up and Maintenance Time

Worker	Time arrived at job site	Time operation begins	Non-productive duties
J. Doe - feller	6:45 A.M.	7:30 A.M.	Sharpened saw, fueled up, changed air filter

It is realized that a certain portion of each working day is spent on maintenance work and warming up equipment. The purpose of these observations is to determine the size of this portion.

The entry in the first column should refer to the worker, either by duty, or, if the individuals are known by name, this is preferable.

The second column is for recording either the time individual arrived or the time the daily pay starts. In the next column, the time that the individual started his regular duties should be noted.

The entry under Non-productive Duties should be a brief description of the duties the individual performed in the interim.

A sample entry is shown in the table above.

Primary Observations

There should be a primary analysis performed as the data is being collected to determine the regularity of the observation and from this, determine the approximate sample size needed to establish the desired accuracy.

In this study an accuracy which allows the standard error of the mean to lie within $\mp 2\%$ of the mean 80% of the time should be sufficient.

To determine this final sample size, a preliminary sample must be taken. For felling, for all systems, this sample should be large enough to get a concentration of 10 trees in each of the four most common diameter classes. For the bucking operations using the Montague Mill, a sample of 40 trees of random D.B.H. should be sufficient, and for bucking in each of the other two systems a concentration of 10 trees in each of the four most prevalent diameter classes will be sufficient. In gathering this data, all the material being felled or moving across the deck should be timed and the information recorded, and the time stopped only when the desired concentration is reached. It is mandatory that a comprehension of the spread in the diameters be gained as well as the operating time for each.

For the skidding operation, a sampling of ten turns should be taken, and the loading sample should include the times per log for 1 load for the longwood and integrated systems.

Since most of the data will be classified into D.B.H. or diameter classes, the easiest way to determine this sample size is to plot the functions over D.B.H. or diameter, etc., and fit a curve to this data by either linear or curvilinear regression.

Once this has been done, the sample size can be determined by using the formula

$$N = \frac{t^2 S^2}{S\bar{X}^2}$$

where
N = the necessary sample size
t = 1.28 (for the 80% accuracy level)
S = standard error of the population
$S\bar{X}$ = standard error of the mean

For the other data - such as, walking rate, skidding, tractor travel speed, etc. - an arithmetic average with the standard error and standard error of the mean computed can be used in the same manner.

The major purpose of this analysis is to determine the elements

in which the greatest degree of regularity exists. These areas will require a lesser amount of sampling than the others, and to make maximum use of the time allocated for the study it is pertinent that the amount of effort required be known early in the study.

The second function of the preliminary study is to determine some of the more obscure relationships. For instance, it is very difficult to estimate the effect tree size will have on the bunching element of the skidding operation. After a preliminary sampling of 40 trees, the effect of tree size should become evident if it exerts any influence, or some other factor may become apparent which will exert the most influence.

Table I

Cost center	System	Equipment	Fixed charges	Variable charges	Coefficients needed	Data necessary
Transporting crew	MM LW I	Panel truck Panel truck Panel truck	Driver Investment Insurance License Taxes	Gas Tires Oil Maintenance	Time / Distance → $ / mile to be converted finally to $/cord	Truck miles Travel time Number of stops Fuel consumption Oil consumption Maintenance charges Tire mileage/fixed charges
Felling	MM LW I	Chain saw and skidding tractor (Used part time for ringing)	Investment Insurance Carrying charges Service equipment (grease guns, fuel tank)	Labor Fuel Maintenance Oil	Man-hours/tree by D.B.H. Stocking and volume/acre Ringing time/acre to be converted finally to $/cord and $/acre	Time: Severance, Limbing, Walking, Decision, Delay Ringing time with tractor
Skidding	MM	Mill	Investment Insurance Carrying charges	Labor Fuel Maintenance	Bucking time/tree by D.B.H. Feed time by D.B.H. Cords/hour by D.B.H. $/cord by D.B.H.	Bucking time/stick Number of bolts Feed time/stick Delay time
	LW	Chain saw			Bucking time/tree by D.B.H. Cords/hour by D.B.H. $/cord by D.B.H.	Time/cut by depth of cut Interval between cuts Lengths of bucked material by D.B.H. class Delay time
	I	Chain saw			Bucking time/tree by D.B.H. Cords/hour by D.B.H. $/cord by D.B.H.	

Cost center	System	Equipment	Fixed charges	Variable charges	Coefficients needed	Data necessary
Skidding	MM	2 crawlers w/arches	Investment Insurance Carrying charges Service equipment	Labor Fuel Maintenance	Man and machine hours/cord by D.B.H. classes	Round-trip travel time Skidding distance Hook and unhook time Delay time
	LV	2 crawlers w/arches				
	I	2 crawlers w/arches				
Bucking on deck	MM	Mill	Investment Insurance Carrying charges Service equipment	Labor Fuel Maintenance	Bucking time/tree by D.B.H. Feed time by D.B.H. Cords/hour by D.B.H. $/cord by D.B.H.	Feed time/stick by D.B.H. Bucking time/stick by D.B.H. Number of bolts Delay time
	LV	Chain saws			Bucking time/tree by D.B.H. Cords/hour by D.B.H. $/cord by D.B.H.	Time/cut by diameter of cut Interval between cuts Length of bucked material by D.B.H. classes
	I	Chain saws			Bucking time/tree by D.B.H. Cords/hour by D.B.H. $/cord by D.B.H.	Time/cut by diameter of cut Interval between cuts Length of bucked material by D.B.H. classes

Cost center	System	Equipment	Fixed charges	Variable charges	Coefficients needed	Data necessary
Loading	MM	Mill	Investment Insurance Carrying charges Service equipment	1 man	Time/unit: by D.B.H. class Cut No. of stems Volume	Time/log by length and diameter Cold-decking times Delay times Truck stand by times
	LN	Crane or L. Dream		3 men + fuel, oil, maintenance		
	I	Crane or L. Dream		3 men + fuel, oil, maintenance		
Overhead	MM LN I				Costs of moving to new location Clerical charges/day Personal car expense/mile and miles/day Salary	Ask questions

Table I

Cost center	System	Equipment	Fixed charges	Variable charges	Coefficients needed	Data necessary
Transporting crew	MM LW I	Panel truck Panel truck Panel truck	Driver Investment Insurance License Taxes	Gas Tires Oil Maintenance	Time / Distance → $ / mile to be converted finally to $/cord	Truck miles Travel time Number of stops Fuel consumption Oil consumption Maintenance charges Tire mileage/fixed charges
Felling	MM LW I	Chain saw and skidding tractor (Used part time for ringing)	Investment Insurance Carrying charges Service equipment (grease guns, fuel tank)	Labor Fuel Maintenance Oil	Man-hours/tree by D.B.H. Stocking and volume/acre Ringing time/acre to be converted finally to $/cord and $/acre	Time: Severance Limbing Walking Decision Delay Ringing time with tractor
Skidding	MM	Mill	Investment Insurance Carrying charges	Labor Fuel Maintenance	Bucking time/tree by D.B.H. Feed time by D.B.H. Cords/hour by D.B.H. $/cord by D.B.H.	Bucking time/stick Number of bolts Feed time/stick Delay time
	LW	Chain saw			Bucking time/tree by D.B.H. Cords/hour by D.B.H. $/cord by D.B.H.	Time/cut by depth of cut Interval between cuts
	I	Chain saw			Bucking time/tree by D.B.H. Cords/hour by D.B.H. $/cord by D.B.H.	Lengths of bucked material by D.B.H. class Delay time

Cost center	System	Equipment	Fixed charges	Variable charges	Coefficients needed	Data necessary
Skidding	MM	2 crawlers w/arches	Investment Insurance Carrying charges Service equipment	Labor Fuel Maintenance	Man and machine hours/cord by D.B.H. classes	Round-trip travel time Skidding distance Hook and unhook time Delay time
	LV	2 crawlers w/arches				
	I	2 crawlers w/arches				
Bucking on deck	MM	Mill	Investment Insurance Carrying charges Service equipment	Labor Fuel Maintenance	Bucking time/tree by D.B.H. Feed time by D.B.H. Cords/hour by D.B.H. $/cord by D.B.H.	Feed time/stick by D.B.H. Bucking time/stick by D.B.H. Number of bolts Delay time
	LV	Chain saws			Bucking time/tree by D.B.H. Cords/hour by D.B.H. $/cord by D.B.H.	Time/cut by diameter of cut Interval between cuts Length of bucked material by D.B.H. classes
	I	Chain saws			Bucking time/tree by D.B.H. Cords/hour by D.B.H. $/cord by D.B.H.	Time/cut by diameter of cut Interval between cuts Length of bucked material by D.B.H. classes

Cost center	System	Equipment	Fixed charges	Variable charges	Coefficients needed	Data necessary
Loading	MM	Mill	Investment Insurance Carrying charges Service equipment	1 man	Time/unit: by D.B.H. class Cut No. of stems Volume	Time/log by length and diameter Cold-decking times Delay times Truck stand by times
	LN	Crane or L. Dream		3 men + fuel, oil, maintenance		
	I	Crane or L. Dream		3 men + fuel, oil, maintenance		
Overhead	MM LN I				Costs of moving to new location Clerical charges/day Personal car expense/mile and miles/day Salary	Ask questions

REPORT ON VISIT TO J. H. (KIRK) DUNN'S PULPWOODING OPERATION

Location

The area on which the crew was working during this visit is known as the Gatling tract, now owned by T. J. Pearsall, and is located three miles off Route 44, eight miles south of Oak City in Martin County, North Carolina.

The area is in a pocosin and is stocked with a natural-growth stand of loblolly pine. The brush-and-reed ground cover was very dense, restricting movement and vision. The cutting was a diameter-limit thinning operation in an unmarked stand.

The Operation

A C-5 Garrett Tree Farmer was used to skid a 1.6-cord pulpwood pallet on a skidding pan from stump to stump.

The felling was done by two crews consisting of a feller and a piler equipped with a single-bit ax and Poulan Model 82 chain saws. The feller was responsible for getting the trees on the ground, limbing the larger-sized limbs, and bucking the stem into bolts. The piler did a small amount of brushing for the feller, chopped off the smaller limbs and piled the bolts for pickup by the loading crew.

The loading crew consisted of four men, a Garrett C-5 Tree Farmer equipped with a blade, and pulling a skid pan with a 1.6-cord pulpwood pallet on it.

The tractor driver's duties were:

(1) To move the pallet from pile to pile.
(2) To plan his moves while the loaders were throwing the pile onto the pallet.
(3) To move the loaded pallet to the deck and, with the help of one member of the loading crew, drop the loaded pallet and place an empty pallet on the pan for the next turn.

The loading crew consisted of three men, each equipped with a pulpwood hook and with one ax for the crew. It was their responsibility to load the piled wood onto the pallet, to brush out around the piles, and to help the tractor driver plan his moves.

The Visit

The operation was visited on December 9, 10, and 11, 1964. The weather was agreeable on all three days, the temperature being in the thirties and forties in the early morning and rising to the low sixties in the early afternoon. Although it had rained a few days prior to the visit, the roads were firm; and heavy brush in the woods provided a mat which eliminated, for the most part, traction and flotation problems.

I was on the job Wednesday and Thursday, during which time I concentrated on the loading crew, timing the loading of 14 pallets. A universal joint broke on the Tree Farmer about 4:00 P. M. on December 10, and the loading was halted for the remainder of that day although the crew continued to fell and pile until 5:00 P. M. The part was still unavailable by Friday morning, and the entire operation was closed down for the day.

Although the sample was limited, I feel that it was indicative of the time allocation to the various elements of the loading function and that it can be used to point out a few trouble spots.

Results and Recommendations

The average time to load one pallet and deliver it to the deck during the visit was 38.66 minutes, which would give an average daily production of 12.5 pallets, or 20 cords. It must be noted that during the course of the study the crew was very much aware of the presence of the observer and was more productive than normally. The normal production of this crew averages 10 pallets a day, or 16 cords.

Some Recommendations for Increasing Productivity

The breakdown of time during the period when the Tree Farmer and pallet is in the woods is as follows:

Moving time (between piles)	12%
Loading time	68%
Brushing time	14%
Delay time	5%

One method of increasing productivity would be to urge the pilers to eliminate as many of the small piles as possible. Forty-two percent, or 55, of the stops was for piles of five or less sticks. Excluding

the initial stops in each pallet, thirteen of the remaining forty-nine stops followed moves of less than ten feet. The loading time per stick is much higher on these small piles. Consequently, these piles are more expensive to handle, whichever method, hand loading or mechanically, and cause an increase in the loading costs.

With hand loading, the loading time per stick drops rapidly with increasing pile size until piles of about eight sticks are reached, and remains fairly constant with increasing pile size from there on.

With a little more planning in the felling and loading operations, many of the closely spaced small piles would be eliminated, which should have an effect on increasing production.

This would become even more important with the use of the Gaffner loader, for the cycle time with this machine will be approximately the same, whether handling one stick or five. There will also be a certain amount of fixed time per stop with this loader; namely, releasing the grapple from its rest and replacing it, and getting the machine into position to load. This time will be more important in terms of productivity when dealing with small piles.

Using the hydraulic loader would quite possibly eliminate most of the brushing time in the above chart, also.

When the loading part is considered as a portion of the loading-skidding function performed by the Tree Farmer, another area, which has a strong influence on production, emerges. The breakdown of times is then:

Moving time (between piles)	12%
Loading time	40%
Tractor traveling to deck	31%
Tractor delay*	7%
Crew delay	7%
Brushing	2%

*During the visit, the tractor went to the other show twice to pull out a stuck skidding tractor.

Here the tractor is involved in skidding a full pallet to the deck

and returning with an empty one for nearly as long a time as with loading. During my visit, this distance was about 1,000 feet, but I understand it may reach one-half mile or more in some instances.

If another machine were used to move the pallet from the work area to the deck and return with an empty one and pan while the Tree Farmer is loading a second pallet, production could be significantly increased.

Using the data gathered during this visit, if the travel time with the full pallet were reduced to one quarter of its present level, considering it only as a hook-unhook time, the average time per pallet would be as follows:

Loading time	15.87 minutes
In-woods moving time	4.89 "
Delay time	2.96 "
Brushing time	.78 "
Hook-unhook time	3.18 "
Total time	27.68 "

Considering this as opposed to the average of 38.66 minutes now used in preparing and delivering one pallet, this would give a potential production of 17.5 pallets a day, or five more than the system is capable of producing at present.

This would require an investment in another skidding machine, pallet pan, and hiring one more man. I feel that if the Farm-All tractor which was discussed as being used in this capacity, were capable of doing this, the investment of $500 in this tractor, $150 in another pallet, the addition of one more man to the payroll could be quickly offset by the increased production.

By adding the Gaffner loader to the Tree Farmer, the machine will become a combination skidder and loader. Because of the capabilities of this combination, it will be of increased importance to use it for this purpose as much as possible.

The use of the hydraulic loader will also allow all wood to be cut to 6-foot lengths. At present, the felling crew is pressured by the loading crew to cut the larger-diameter bolts to shorter lengths to make them easier to load. This results in a significant loss of volume on the pallet. To maximize the available space on the pallet, and to make the pallet easy to maneuver through the woods, the felling

crew should be instructed to cut all of the bolts as nearly 6 feet long as possible, regardless of diameter.

During the time of the visit, the length of bolt ranged from 3' 11" to approximately 7' 2". The shorter bolts reduced the volume per pallet, and the longer bolts had a tendency to snag on standing timber while the pallet was being moved.

A convenient measuring device for the felling crew can be built into the saw. Measure three feet from the limbing guard on the blade toward the rear of the saw and put a mark on the top of the saw at this point. The operator can then put the limbing guard on the end of the section to be cut and lay the saw on the top of the log, look down on the saw and sight the three-foot mark; then repeat the procedure to reach a six-foot length. This will give the crew a convenient check on the performance and will not require another piece of equipment for them to carry.

A measuring device of some nature could be made for use on diameter-limit thinnings of this type. One of the fellers had a stick which he used often, but the other spent considerable time debating whether or not to remove a tree which was near the limit.

One change in the present equipment which could be tried is the substitution of "Boy's Axes," the 2¼-to-2½-pound single-bitted ax with the 26-to-28-inch handle for the 3½-to-4-pound axes now used. These axes are now used extensively in the Northeast and are popular with the crews there. The smaller axes have the advantages of the larger, single-bitted ax but are especially useful in close-quarter work because of their shorter length, and, because of their size, are less tiring to carry.

Safety

Several improvements could be made in the area of safety. The first should be the introduction of hard hats and steel-toed shoes. Since most of the resistance of the crew to hard hats seems to be predicated on their dislike of the tendency of the hat to catch on brush, the baseball-type hard hat might be tried. These are smaller and better balanced, and offer nearly the same amount of protection as the larger type.

Steel-toed shoes are recommended for the members of the crew

for the obvious reason that there is always danger of a bolt falling on a man's foot.

The tractor driver should be instructed in using his machine for pushing down lodged trees whenever he can. This will eliminate some of the delay in both the felling and the skidding crews. Guards may also be tried on the bow saws. These have been found very useful and easily maneuvered in several studies.

Future Plans

A great deal of insight into the operation was gained through this study, but much is left undone.

Cost figures should be developed for equipment and crews to be used in evaluating improvements and in considering other changes in the system.

Another visit should be arranged after the Gaffner loader is in operation to determine the immediate effects on production, and a second visit some months later after the system has become stabilized around this piece of equipment.

I hope to keep working with Mr. Dunn on a long-time-cooperator basis, using the materials and techniques developed with him as a guide for other endeavors.

William B. Stuart

N. C. State College
Select Tree Rating Sheet
Fraser Fir

Form C-5

Organization_____ N. C. Ascen. No._____

State_____ Management_____

County_____ Sheared (Intensity, time and number)

Grader_____ _____

Date_____ _____

Tree Height_____ Fertilized (Rate, time and number)

Tree Age_____ _____

Cones_____ _____

Owner_____ Cultivated_____

Spray_____

Select Tree Score:

Remarks:

1. Color _____
2. Crown density _____
3. Developed Lateral buds_____
4. Limb Angle _____
5. Growth Rate _____
6. Tree shape _____
7. Needle length _____

Total _____

*This form has been developed specifically for grading Fraser fir for suitability for Christmas trees. Each tree is graded directly upon it qualifications - no direct comparison is made with check trees, but it will be graded in in comparison with other trees in the plantation treated as the graded tree was treated. A vital consideration is whether the trees have been sheared or fertilized; the point scores will depend on the amount of care a tree has had. The ideal is to grade trees that have been neither sheared nor fertilized. No diseased, deformed (forked) or insect-attacked trees will be considered. Fertilized plantations will be graded on a separate total point system from the unfertilized plantations.