TREE SEED HANDLING IN NEW YORK

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The Bureau of Nurseries of the New York State Conservation Department is obligated to produce from 36 to 60 million seedlings per year for planting within the State. To produce this many trees annually requires a total for all species of 4,000 to 7,000 pounds of seed.

Tree seed is not a common commodity on the market, at least of the species and source desirable, so that procurement presents several problems. In New York State tree seed is 'obtained through direct purchase of seed from seed dealers and the collection or purchase of cones within the State. The cones are purchased directly from cone pickers at a bushel rate, or labor is hired to pick cones on an hourly basis.

Seed source is important. A seed source that will adversely affect the survival of the trees in the nursery and growth of the trees in the plantations can cause a serious economic loss. Every effort is used to obtain information on the seed source, and this information is carried by means of lot numbers in the nursery and planting records.

Specifications should be set up for the purchase of tree seed, just as they are for the purchase of other, commodities. The source specification must be in keeping with the possible supply available from a given species, and often some previous knowledge is useful in seeing that specifications are not written for seed which is not available. The specifications generally limit the area from which the seed is to be collected, by naming the region, State, or county or by reference to latitude and longitude. Also specifications may be made on elevation where this is important. The collection year is usually required and while it is important in relation to seed quality, it may also be of value in relation to other possible information. Since forest seed is very expensive, specifications on germination percent and purity percent are especially needed. Tree seed which germinates normally at 90 percent or better is at least twice as valuable as seed which germinates 50 to 60 percent. And when seed cost ranges from 12 to 20 percent of the cost of growing seedlings it is important. In the case of seed purchases, provisions should be made in the specifications for adjustments where the seed fails to meet the requirements.

Cone purchases in the Adirondacks starting with 1929, and principally in the years of 1929, 1932, 1938, and 1947, have totaled more than 46, 000 bushels.

These were purchased on the spot from local independent cone pickers. Hired labor in the various districts of the State has picked some 15, 000 bushels of cones; this is a more recent development and the cones are mostly obtained from State-owned plantations. This plan has proved very successful with white spruce which produces an ample crop one small trees. Where labor is hired to pick such species as red and Scotch pine, the cost per bushel is about double that from the independent pickers. However, there are other factors, such as control of collectors on certain plantations, that often make it more desirable to hire men to pick cones.

The collected cones are transported to the Saratoga Nursery where they are stored until the seed can be extracted. The extraction process is well known and needs little description here. The cones are oven dried and when sufficiently open release their seed. The seed is then cleaned. In the cleaning seed of some species must be dampened so that the wings can be removed completely. Such seed is then dried to 5 to 8 percent moisture and sealed into to large glass carboys which are stored in a refrigerated vault.

The weekly production capacity of the seed plant, and especially the time necessary in the oven, depends upon the species. For red pine production is about 100 pounds a week, and with white pine, white spruce, and norway spruce from 300 to 500 pounds a week. A Holland grain dryer is now being modified to dry the cones at the Saratoga nursery.

Seed storage capacity is about 20, 000 pounds. Seed that is properly dried, sealed, and kept at 36^0 F. the year around will not lose viability in the first 10 years. Therefore, the policy is to purchase cones and seed when funds are available, and actually stockpile for the future, since 10 years is adequate for a practical operation

Samples of seed are dried in an electric oven and the moisture percentage calculated. Also, an electronic seed moisture tester is being calibrated for more rapid determinations.

The carboys of seed in storage are labeled, with all the known information on a special tag. Complete inventories of the seed are made twice each year and tabulated by container number, species, source, and pounds in each container.

Tree seed testing has been a regular practice since 1931 in the nursery laboratory at Saratoga. Tests are made in connection with extraction processes, and especially for checking seed in storage and for sowing in the seedbeds. Complete records are on file on a "Seed Record" form. A special "Seed Test Report" form carries the essential information obtained from a test; this can be used in calculating the amount of seed to sow.

Preparation for seed sowing follows a more or less set procedure. First is to determine the planting stock demands by species. If adequate seed is available to meet these demands, the number of seedbeds to sow at each nursery is determined, based upon the available space and nearness to likely planting sites. Germination percentage for each lot is used to determine for each nursery the amount of seed to sow. The most recent experience with the same lot of seed is perhaps the best guide. Also useful are the results in general with the species over a period of years as indicated by an experience table. Finally the rate and pounds to be used at each nursery is arrived at.

An important item to consider is the seen lot number which identifies the lot throughout the whole process from extraction through seed sowing, lifting the trees for planting, and packing to the plantation. When and how is this lot number determined and how handled throughout the seed and tree handling.

It is impractical to try to work with too many seed lot numbers for a given species. In fact, there is no use having lot numbers at all, if all the numbers cannot be separate in all the operations. In practice the number is kept to a minimum and handled so as to reduce the possibility of mixing the lots of a single species.

When cones of a single species are received from a forest district a number is assigned. Also when a lot of seed is received from a dealer it is given a seed lot number. This number is used during extraction and storage. However, where the seed of certain species all come from a mixture of plantations and different districts and the source data are not important enough to keep separate by districts, certain numbers are combined so that there is only one seed lot number at sowing time. This is done especially with many of the smaller lots.

At sowing time seed lots of a single species are as far as possible kept separate by nurseries or by sowing seasons. If two or more are sown at a given time at one nursery, they are sown in separate blocks. A nurseryman's nightmare is to have two or more lots in the same block at lifting time, looking alike. When possible, one lot is lifted at a time and completely cleared before the next one is lifted. Trees going to the packing shed carry on a tag the seed lot number, species, and age. The packers report the seed lot number used and a record is made at that time on the shipping record form. This seed lot number eventually appears on the tree order form, which is made a permanent record. The meaning of each number is filed on a separate record. Form 186 SL "Seed Lot Record" (fig. 1) provides a ready reference for those who wish to know the source data on the planting stock, as well as an index to other records on seed tests, extraction and storage, sowing and stock disposition.

Where there are several special seed sources, which produce small amounts, yet are important to keep separate, they are sown in separate seedbeds and given special handling during all the lifting and shipping procedures.

Forestry Form 186-SL

SEED LOT RECORD

Seed Lot No. _____ Species _____ Pounds in Lot _____

Seed Received from _____ Date Received _____

Received as: Cones _____ Seed _____ Fruit _____ Other _____

Senders Marks: Lot No., Order No., etc. _____

Source: Data as stated by Dealer or Collector _____

_____

Collected by _____ Date Coll. _____

Place Collected: _____

GERMINATION TESTS: DATES TEST NOS. GERM. ENERGY %

_____

_____

_____

EXTRACTION AND STORAGE

Cone Storage _____ Place Extracted _____ Date Ext. _____

Date Seed Stored _____ Place Stored _____ Container _____

Temp. in Storage _____ F Remarks _____

SOWING RECORD

	Nursery	Date & Season Sown	No. of Beds 4 X 12	Ozs. per Bed	Lbs Sown	Inventory (M) 1-0	2-0	3-0	Lifting Count
1.									
2.									
3.									
4.									
5.									
6.									
	Totals								

DISPOSITION OF STOCK: Sowing No. (above), Age, Year & Season, Private Orders or State Land. Any Details on State Areas.

Figure 1.-Seed lot record form

STRATIFY YELLOW-POPLAR SEED OR SOW DIRECTLY?

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A frequent topic of discussion among nurserymen in the Central States region is the best treatment for yellow-poplar seed before sowing. At the Marietta State Forest Nursery in Ohio, stratifying the seed in sand for one or more years has given the best results. On the other hand, State and Federal nurseries in Indiana and Illinois frequently sow seed of this species in the fall shortly after collection. This divergence of practices may be explained by a current source study of this species. The study shows that the best presowing treatment of yellow-poplar seed may vary by seed sources, conditions affecting seed formation and dormancy, or other factors not yet fully understood.

In the fall of 1952 yellow-poplar seed from eight different sources in the three States was collected for use in a seed-source study. Samples of seed from each of these sources were selected at random and sown at the U. S. Forest Service Nursery, Vallonia, Ind., in the fall of 1952. Other samples from the same collections were stratified deeply in sand at the nursery until the fall of 1955 and then sown. Stratified seed from all Ohio and Illinois sources produced a much higher percentage of seedlings than did seed sown immediately after collection in the fall (table 1). For the Indiana sources, on the other hand, the reverse is true: direct sowing was superior to stratification.

Table 1.--Percentage of yellow-poplar seeds that germinated and survived for 1 year (tree percent) by seed treatment and seed source (U. S. Forest Service Nursery, Vallonia, Ind.

Seed Source	Seed Treatment	
	Sown immediately after collecting	Stratified 3 years
Zaleski, Ohio	0.15	2.96
Athens, Ohio (B)	1.06	3.83
Marietta, Ohio	1.52	6.79
Athens, Ohio (A)	1.87	7.79
Hardin Co., Ill.	1.55	2.88
Jonesboro, Ill.	2.95	4.35
Cannelton, Ind.	7.68	6.21
Dexter, Ind.	12.00	7.73

In tests of this kind it is impossible to control all variables that may affect germination and survival. Presowing seedbed treatments, weather, fertility, watering schedules, and so forth are difficult to duplicate in two different seasons even at the same nursery. But the results differ so widely--more than 300 percent in four out of eight cases--that there is little doubt seed stratification influences the germination of yellow-poplar seed. The reasons for this variation in germination habits among different seed sources are not known. However, it is plain that a knowledge of how the effects of stratification vary among different seed sources may result in more as well as better seedlings.

Another study shows that apparently stratification also influences date of germination and hence the number of plantable 1-0 seedlings that can be grown. Seed from six of the above sources was collected from the same seed trees 3 different years. Those collected the first 2 years were stratified; those collected the third year were not. All were sown at the Vallonia Nursery in the fall of 1955. The strikingly greater percentage of seedlings taller than 6 inches produced from the stratified seed is evidence that stratified seed must have germinated much earlier than seed sown directly (table 2). Again, there were wide differences among seed sources.

Table 2.--Percent of seedlings more than 6 inches tall 1 year after sowing.

Seed source	Collected 1952 Stratified 3 yrs., sown fall 1955	Collected 1954 Stratified 1 yr., sown fall 1955	Collected 1955 sown fall 1955
Marietta, Ohio	62	90	41
Athens, Ohio (A)	62	51	44
Zaleski, Ohio	72	48	23
Athens, Ohio (B)	77	68	7
Cannelton, Indiana	88	73	56
Hardin Co., Illinois	90	95	78

STRATIFICATION HARMFUL TO SOME LOBLOLLY AND SLASH PINE SEED

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Seed dormancy plays an important role in nursery practices. The most critical time in the nursery operation is the germination period when high winds, heavy rains, unseasonable cold weather, and damping-off can cause serious losses. The primary aim of stratification is to shorten the germination period by overcoming seed dormancy. To accomplish this most nurserymen are willing to sacrifice some of the total germination.

Loblolly (Pinus taeda L.) and slash pine (Pinus elliottii Engelm.) seed sometimes have an inherent dormancy at maturity. Subsequent handling in seed extraction and storage may accentuate this dormancy, which cannot be detected by visual examination. The exact nature of dormancy is not known but there are apparently no racial differences in dormancy in either species. Seed samples sent to the Seed Testing Laboratory come from all parts of the range of both species and attempts to correlate seed dormancy and geographic source have been unsuccessful.

Since the first application by Barton 2/ in 1927 of cold, moist stratification to break dormancy of southern pine seed, this practice has become generally used. All seed lots of a species are usually stratified or not stratified, as decided by the nurseryman according to his past experience.

However, Wakeley 3/ has reported that stratification of all lots of a species has resulted in no benefit with some lots and actual loss of germination with others. He has recommended that only those seed lots be stratified that show a beneficial response as determined by paired germination tests of stratified and unstratified seed.

1 / In cooperation with the Southeastern Forest Experiment Station, Forest Service, U. S. Department of Agriculture, the Georgia Forestry Commission, and the Georgia Forest Research Council.

2/ Barton, L. V. Hastening the Germination of Southern Pine Seed. Jour. Forestry 26: 774-785. 1928

3/ Wakeley, P. C. Planting the Southern Pines. U. S. Dept. Agr. Monog. 18, 233 pp., illus. 1954.

In an attempt to demonstrate the wisdom of preliminary, paired germination tests, 67 lots of loblolly pine seed and 26 lots of slash pine seed, both stratified and unstratified were tested in 1956. In 1957, 74 lots of loblolly pine seed and 41 lots of slash pine seed were similarly tested. The seed was stratified in wet peat moss for 30 days at 34-38°F. The mean germination percentage was determined by tests of 100 seed replicated eight times on a medium composed of half sand and half vermiculite.

The effects of stratification were classified as follows (table 1):

Benefited- -Increased germination 6 percent or more or decreased the number of days to reach maximum germination by 6 days or more.

Injured--- Decreased total germination by 6 percent or more or increased the number of days to reach maximum germination by 6 days or more.

Unaffected--Change of less than 6 percent in total germination or less than 6 days to reach maximum germination.

Table 1.--Effect of stratification upon the germination of loblolly and slash pine seed

Species and year tested	Seed lots tested	Effect of Stratification		
		Benefited	Injured	Unaffected
	Number	Percent	Percent	Percent
Slash pine:				
1956	26	15	35	50
1957	41	15	66	19
Average		15	54	31
Loblolly pine:				
1956	67	48	7	45
1957	74	65	9	26
Average		57	8	35

Over the 2 year period 57 percent of the loblolly lots and 15 percent of the slash lots benefited by stratification. An average of 54 percent of the slash and 8 percent of the loblolly were injured. A decision to stratify or to not stratify all lots of either species is not justified, especially in view of the chronic shortages of the seed of both species. The most efficient use of available supplies requires a stratification decision based upon individual lot characteristics. The need for stratification can only be determined by comparative tests of unstratified and stratified seed.

SEED PELLETING PROCESS FOR BIRD AND DISEASE CONTROL

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Pelleting seed is done at Vallonia Nursery for both bird repelling and early damping-off control. The following products have one or both of the above effects: (1) Arasan, 75% (SFX); (2) endrin, 50% W; (3) orthocide, 50 W. Bird and rodent repelling is increased by the addition of (1) anthraquinone; (2) Morkit; or (3) aluminum powder, flaked (paint stores). Sticker or pelleting slurry is made from (1) Dow latex 512 R; (2) Dow methycellulose; or (3) Flintkote, hydrol C-13-HCP emulsion.

One of each group may be used with good results. There may be other manufactured products that will work equally well. The details given in this article are strictly informative and no recommendation of any manufacturer's product is intended.

Equipment

Scales and measures for weighing or measuring seed and chemicals, 5-gallon cans for mixing slurry, dust respirator, goggles, rubber gloves, cement mixer (or agitator, 20-gallon semesan drum mixer, or Dybvig seed cleaner), and screens or trays for treated seed.

The materials should all be weighed or measured out before putting the seed in the mixer. As soon as the seed is in the mixer add the adhesive slurry (latex, methocellulose, or asphalt emulsion). As soon as all the seeds are moist (about 20 revolutions of mixer) add the fungicide (Arasan, endrin, or orthocide), allow to mix for about 30 seconds or 20 turns and add the repellent (anthraquinone, Morkit or aluminum powder). The seed should make another 20 turns or 30 seconds, which should give all seeds a good coating of the final repellent. It is then removed from the mixer and spread out on screens or trays to dry. The total mixing time should not exceed 3 or 4 minutes, because long agitation may injure seed or chip off the pelleted coat.

Adhesive

The adhesive that we are currently using is Dow latex 512R (Dow Chemical C.o., Midland, Mich.), about $2 per gallon. One gallon will treat at least 300 pounds of pine seed. The latex is diluted with water, one part latex to nine parts of water. The amount needed for a 10-pound batch of seed is about 1 pint of the resulting slurry. The seed should then be moist but not excessively wet. Mix only enough slurry for the seed to be treated.

Another product that may be used with satisfactory results is Dow Methocel Powder 100 CPS. This slurry is made by mixing 2 ounces of methocel powder in 1 /2 pint of hot water to a thin paste; then add 1 gallon of cold water, stir well, and allow to congeal over night. As with latex, one pint of slurry is used for a 10-pound batch of seed. Excessive rubbing of dry treated seed should be avoided.

Satisfactory techniques for using the Flintkote asphalt adhesive have not been developed as yet at this nursery.

Fungicide

Equally good results have been obtained with Arasan 75% (SFX) (Du Pont Chemical Co.), endrin 50% W, or orthocide 50 W (California Spray Chemical Co., 1000 Maxwell Ave., Evansville, Ind.). All three fungicides seem to have repellent effect on birds and rodents. Only one need be used. Simply use the powder at the rate of 1 pint (about 1 /4 pound) per 10-pound batch of seed.

Endrin, Arasan, and orthocide cost about $2 per pound, are usually available locally, and can be used interchangeably in the process.

Repellent

Morkit, the imported anthraquinone,- has been discarded in favor of our more AC. effective American anthraquinone. We use sublimed synthetic anthroquinone (American Cyanamid Co., Rockefeller Plaza, New York 20, N. Y.). The patent for the use of this material as a bird repellent is held by Winthrop Laboratories, Inc., New York, N. Y. Licensing agreements are being negotiated. Cost is 80 or 90 cents per pound. About 1 pint of the yellow synthetic powder will dry up the 10-pound batch of wet Arasan pelleted seed, leaving a yellow coated pellet, almost dry. Again there may be other products equally as effective but which are unknown to us at the present time.

The amounts of each of the three components will be varied slightly to adjust to the following: Pine seed size, pine seed coat porosity, dry or stratified seed (wetness),. etc. Experience will govern. If the anthraquinone seed is still wet a small amount of- drier may be added in the form of more anthraquinone or a tablespoonful or two of aluminum powder, flake, or red lead powder, and the batch turned a few more times.

Safety

Endrin is a chlorinated hydrocarbon and is one of the more toxic of the group. A dust respirator and rubber gloves are suggested in blending these items.

USE OF BIRD REPELLENTS FOR NURSERY SOWING

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At the Stuart Nursery, 3, 500 pounds of slash and loblolly seed were treated with bird repellent chemicals before spring sowing in 1957. The two chemicals used were Arasan (50% TMTD) and sublimed anthraquinone. The two stickers used were Flintkote's asphalt emulsion, C-13-HPC and Dow latex, #512R (48% solids).

Quantities of materials used and the costs for 100 pounds of slash or loblolly seed were as follows:

	Amount used	Cost
Arasan	16.6 Pounds	$14.56
Anthraquinone	20.0 Pounds	17.60
Asphalt	1.8 Gallons (dilute in 2 parts water)	2.07
Latex	.3 Gallons (dilute in 9 parts water)	.68

The method of treating seed and the equipment used were similar to that recommended in "Tree Planters' Notes No. 20 of June 1955 by W. F. Mann, Jr. and H. J. Derr.

Batches of 35 pounds of seed were immersed in the sticker solution and allowed to drain. The wet seed and the dry chemical were then placed in the tumbler drum and rotated for 4 minutes. The treated seed was spread on canvas in front of a fan and stirred periodically until the seed was dry enough to feed through the seeding machine. When treating stratified seed, it is not necessary to dry the seed before dipping it in the sticker solution.

Three men treated 2, 400 pounds of seed in 8 hours by this method., This production could be increased considerably by using a small concrete mixer powered with an electric motor instead of the tumbler drum rotated by hand. Sears-Roebuck lists a suitable machine with electric motor for about $85.

Both chemical repellents and stickers gave excellent protection from bird damage. No bird patrols were necessary. In fact it was a problem to find birds on the seedbeds so that their food intake could be examined. Seven mourning doves were shot while on the seedbeds, but none of them had taken any tree seed. In contrast, birds have been a severe problem in previous years. In 1956, for example, 395 mourning doves were shot at the Stuart Nursery. During

a 6-week period, 532 man-hours were spent patrolling and shotgun shells were used costing $93.

The combination of anthraquinone and latex was found to be more desirable than Arasan and asphalt. Anthraquinone is nonirritating to handle. Arasan is very irritating to the eyes, nose and throat of the handlers and retards germination. The seed treated with anthraquinone germinated faster and tests made by the Southern Forest Experiment Station gave a consistently higher total germination for seed treated with this chemical. Latex, which is a white liquid, is cleaner to handle than asphalt, is a better adhesive, and does not cause the seed to stick together after drying, thus permitting better distribution through the seeding machine.

	Source of Supply	
Arasan (50% TMTD)	E. I. Depont De Nemours Co.	Grasselli Chemical Dept. Wilmington, Del.
Sublimed anthraquinone	American Cyanamid Co.	Calco Division Bound Brook, N. J.
Asphalt emulsion C-13-HPC	Flinkote Company	Industrial Products Div., Atlanta, Ga. or New Orleans, La.
Latex #512R (48% solids)	Dow Chemical Company	Midland, Mich.

REPELLENT TREATMENT OF PINE SEED FOR BIRD PROTECTION

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One of the serious problems at the W. W. Ashe nursery has been the protection of pine seed from birds in the beds from the time of sowing through the cotyledon stage. The procedure in the past has been to use a bird patrol with shotguns, or firecrackers inserted into lengths of cotton rope. It was necessary to use various numbers of men from dawn until sundown. The annual expenditure was usually around $3, 500 based on protecting an area producing 30 to 40 million pine seedlings.

The mourning dove caused the greatest damage.

In the fall of 1956 after hearing various reports of successful use of bird repellents, it was decided to try some on fall-sown longleaf seed.

As a check on ease of application, effectiveness as a repellent and effect on germination, four different repellents were used. The treated seed was sown on 18 beds, 4 x 400 feet. Screened plots were set up on the beds to exclude birds and these plots were sown with untreated seed as a check on germination. None of the seed was stratified.

A bird patrol was not used. A daily check was made for damage by birds. When germination was complete, a seedling count per square foot was made. This showed no difference in germination for the treated and untreated seed. All of the seed, regardless of the repellent used, germinated at about the same time.

Although the birds concentrated in the nursery area sown with the above seed, since it contained the only freshly turned soil, there was no bird damage. The treatment was considered successful and plans were made to treat all the seed to be sown during the spring of 1957.

Upon receipt of a report of the work of Harold J. Derr and Brooke Meanley on the use of various bird repellents, a decision was made to use the compound Arasan (Tetramethylthiuram-disulfide 50%). Arasan was favored because the above report showed protection against rodents as well as birds. The area around the nursery contains both rats and mice. Arasan is sold by E. I. DuPont De Nemours & Company.

Approximately 6, 000 pounds of loblolly, slash, sand, and shortleaf pine seed were treated with Arasan and sown on 56 acres of seedbeds during March 1957.

Bird patrols were not used and there was no damage to seed or seedlings. All of the loblolly seed was stratified 30 days or more before treatment.

The method of seed treatment was as follows: A 55-gallon steel drum with one head removed is used to hold an asphalt emulsion mixed at a rate of 3 gallons of water to 1 gallon of asphalt. The asphalt is manufactured by the Flintkote Company and their trade name is Hydrault Protective Coating, Type C-13-HPC. A wire mesh basket slightly smaller in diameter than the drum is filled with a known weight. of seed. The seed are immersed in the asphalt solution and stirred slightly. They are left in only long enough to coat all seed. The basket is raised from the drum and the excess solution allowed to drain back. While the seed drain, 1 pound of the repellent for 4 pounds of longleaf seed, 1 pound for 6 pounds of slash seed, or 1 pound for 8 pounds of loblolly seed, is weighed and placed in a mixing drum. The seed are then poured into the drum which is then rotated slowly for a few minutes so that each seed becomes thoroughly coated.

The seed are then dried in the sun, on canvas, until the coating is firm. They are now ready for planting and may be easily planted with a seeder. Occasionally it may be necessary to clean the excess repellent dust out of the seeder.

The total cost of treating 6, 000 pounds of seed with Arasan was $1,'200.
The usual bird patrol cost has been about $3, 500. It is believed that the seed received better protection than could have been given with a bird patrol. The 14 use of Arasan resulted in a saving of $2, 300 for the nursery.

LEE BOUSFIELD PINE CONE DRYING RACK TAHOE NATIONAL FOREST

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To expedite extraction of pine seed from cones, Lee Bousfield of the Tahoe National Forest designed this drying rack while stationed at the White Cloud Fire Guard Station (fig. 1). The Forest recommends the use of these racks.

Advantages. -Use of a cone drying rack has several advantages over the old method of pouring cones out on a canvas to dry (fig. 2) : 1) Yields more seed, no rodent and bird loss, no crushed seed due to trodding. (2) Reduces drying time. Cones open in 3 to 5 days, depending on ripeness of cone. Operator covers top of cone tray at night with canvas to protect from moist night air. (3) Cones are held about 28 inches above the ground. Drying winds can circulate through the cones. (4) Cones are undamaged and can be sold for Christmas decorations.

Construction. -The cone drying rack is made of common lumber. It consists of three parts, starting at the top: (1) Cone tray, 41 inches by 16 feet, 7-1/2 inches deep. Bottom of tray is covered with 1 inch mesh chicken wire. Holds 4 sacks of cones. (2) Seed drawers, below cone tray (fig. 3). Four drawers to catch seed and wings from cones. Bottoms are made of galvanized iron., 1-1/4 ounce weight. Metal shield 8 inches wide between each pair of drawers. (3) Stand, 28 inches high, 4 by 16 feet.

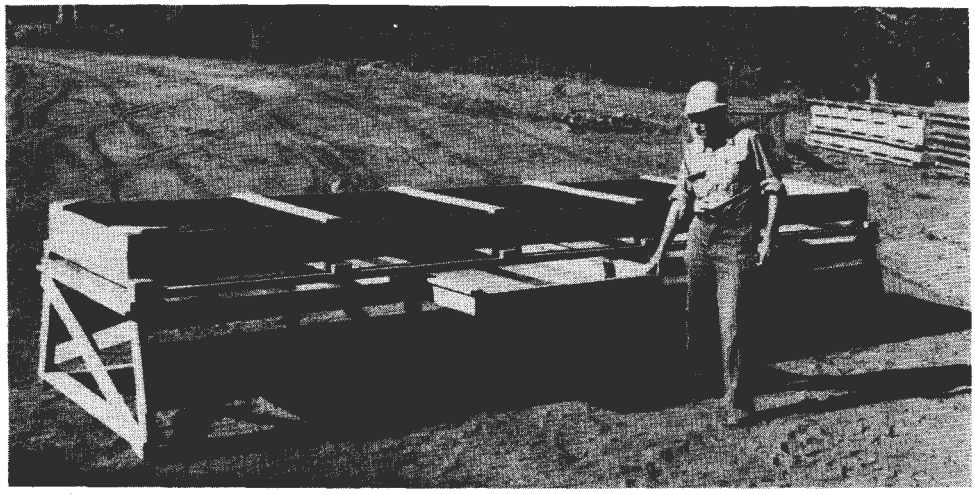

Figure 1.-Bousfield cone drying rack.

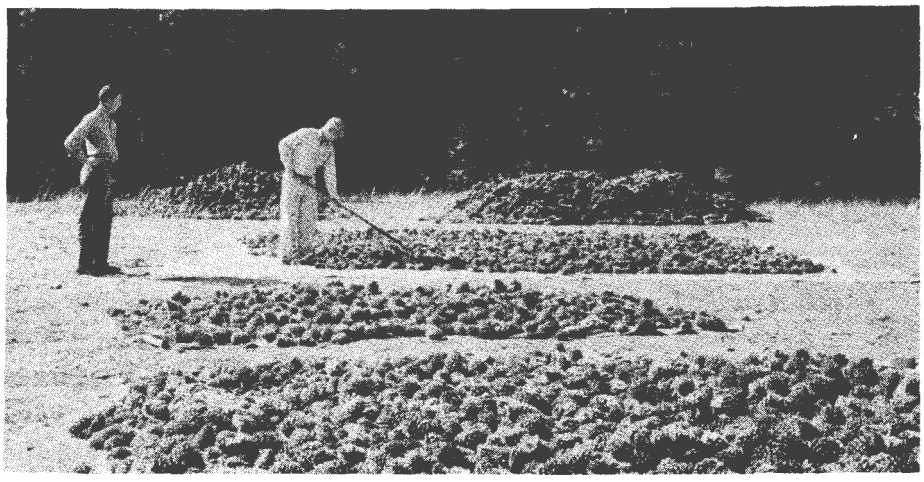

Figure 2.-Old method of spreading cones on canvas to dry.

Operation. -The Tahoe National Forest has 8 drying racks. These are set up at White Cloud Fire Guard Station on the Bloomfield Ranger District about September 1 when cones begin to ripen.

Four sacks of ponderosa pine cones are poured into the top tray of each rack and spread out. Canvas or builder's paper keep dew off at night. Cones are rolled around with a stick about two times a day, as they open. Seeds drop through chicken wire into metal-bottom drawers. When cones are empty, drawers are pulled out and seed is poured into sack. Sacks are labeled as to species, seed zone, forest, and date. They are then ready to send to the nursery for dewinging and cleaning.

Cost. -Racks cost $41 each, $328 for the eight. In addition, extracting seed from 257 sacks of cones cost $2. 20 per sack. Extraction required about 40 days with the 8 racks (5 days per load).

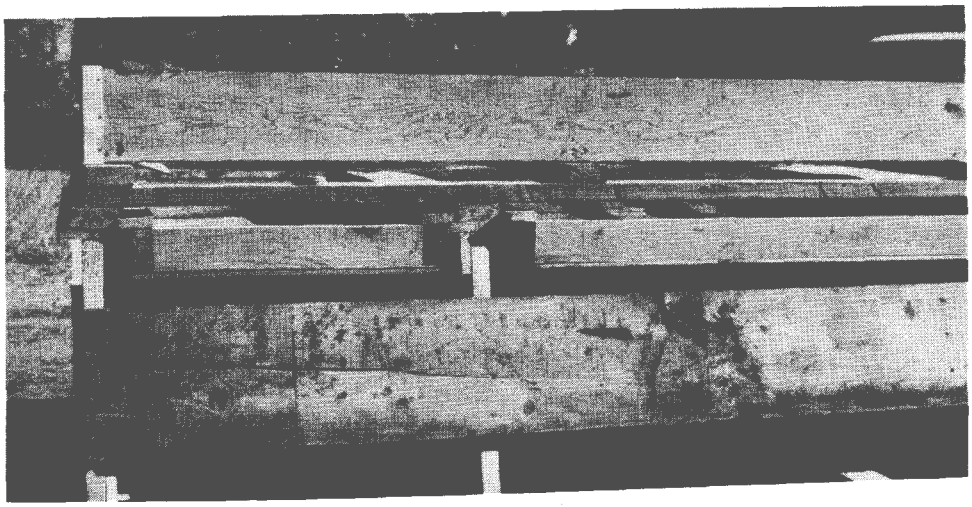

Figure 3.-Details of cone tray at top, seed drawers below.

DIRECT SEEDING: A FAST, RELIABLE METHOD OF REGENERATING LONGLEAF PINE[1]

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The urgency to plant cutover areas of upland forest has in recent years created a demand for pine seedlings that far exceeds the capacity of our nurseries and has prompted foresters and landowners to think seriously of direct seeding as a means of getting their land back into production. In the Gulf States the primary interest has been in direct seeding longleaf pine, while in the Southeast there is wide interest in developing techniques for direct seeding slash pine. Today I will discuss recent developments in the art of longleaf seeding -- with particular reference to those techniques which a forester, launching his first seeding trial, should be most concerned about.

First, perhaps, we should discuss the question, why direct-seed longleaf? Aside from costs and other considerations, those who are direct-seeding longleaf today believe they cannot plant this species successfully. The record of nursery production, in Louisiana at least, testifies to the prevalence of this belief. For lack of demand, the State nurseries have not produced a longleaf seedling for several years.

While we at the Alexandria Research Center do not think that planting longleaf is necessarily impractical, we do think that direct seeding offers several advantages. For this reason we have invested nearly 10 years of research effort in the multitude of biological problems associated with direct seeding.

Four reasons can be cited for using this method of regenerating longleaf. First, it is fast, requiring a minimum of labor. Fifteen years ago one man with a planting bar could, if his back held out, plant an acre of pine seedlings a day. Now, with a planting machine, he can put in 5 to 6 acres per working day. With direct seeding, a skilled pilot in a light airplane can sow 180 acres per hour. On several occasions in the past 2 years 1, 000 acres have been seeded from the air in one day. The second reason for seeding is that it's cheaper. While the cost has fluctuated widely with the cost of seed, it has not

_1/ Paper read March 1, 1957 at meeting of the Texas Chapter, Society of American Foresters at Nacogdoches, Texas.

exceeded $10 per acre. Planting costs for longleaf seedlings have ranged up to $15 per acre. In years when seed is plentiful and cheap, direct seeding costs can be held to about $6 per acre. This includes the cost of seed, seed treatment, and sowing.

The third reason for seeding -- and this one applies particularly to longleaf -is that it provides denser stands than are practical with planting. Yearling stands averaging over 2, 000 seedlings per acre are possible in favorable seasons. A dense seedling catch has a margin for losses during the grass stage, and assures a well-stocked stand later on. Finally, direct seeding is a technique that can be expanded rapidly to take advantage of bumper seed crops.

This final reason prompted our early trials in longleaf seeding at Alexandria. It appeared, in 1947, that if we were ever to make progress in regenerating the 2 million acres of open longleaf land in our territory (which includes two counties in Texas) we would have to think in terms of 1, 000- to 10, 000-acre projects. At that time we did not know how to store longleaf seed for the lean years, so we wanted a method that could utilize the vast amount of seed produced in good years. Longleaf's characteristic of rapid germination also seemed especially adapted to direct seeding.

Our early tests, on small plots, were made to determine basic requirements such as site treatment, time and rate of seeding, etc. We were also testing 4t the theory that birds are the principal obstacle during the fall months.

The early trials were successful, and were followed by a 1, 200-acre venture by the Kisatchie National Forest in 1948. This operation succeeded on areas where fresh seed was used. It encouraged other trials in succeeding years, some of which failed because of bird depredations. The first large seeding operation by a private landowner was by Crosby Chemicals in 1952, when the company started its unique method of tractor seeding on disked strips. Birds were a serious problem on that 900-acre tract, and it was questionable then if bird protection by patrolling was practical for large areas.

The following year preliminary field trials were installed to test Morkit, a German-made bird repellent whose active ingredient was an anthraquinone compound. Results were so encouraging that the Hillyer-Deutsch-Edwards Lumber Company at Oakdale, La., agreed to try Morkit on. 180 acres the following year. This test proved conclusively that birds can be repelled with
a chemical seed coating. Although Morkit is no longer available, other chemicals have proven to be as good or better. The problems in longleaf seeding seem to-be minor now in contrast to the threat of complete loss by birds that faced us only a few years ago. Solving the bird problem has modified some of the recommendations that we formerly thought necessary for successful seeding.

RECOMMENDED METHODS

Site Preparation

Of several site treatments that can be used, a light grass rough provides the best surface environment for germinating longleaf seed. It was recommended originally because of the concealment it provides against birds especially against migratory species, which are attracted to burned or disked areas. However, a light rough also benefits germination, especially when rainfall is light during the early part of the germination period. A case in point was a 1954 test in which Morkit-treated seed was sown on a light rough and on a burn. The rough produced 4, 200 seedlings per acre and the burn 2, 800. Most of the difference was due to germination failures on the burned area during a rainless period that lasted for 19 days after seeding. The development of a reliable bird-repellent now makes it possible to seed on a burn, and in some cases that may be desirable or unavoidable, as on areas burned by wildfire. Certainly where the choice of site treatment is between a fresh burn and a rough that is older than 1 year, the burn is to be preferred. On a burn, seeding should be deferred until late November or early December, when frequent rains can be expected.

Intensive site preparation by disking has been tested for several years, and at least one landowner is using this method on an operational scale. On the difficult sites that foresters are now including in their regeneration plans, intensive treatment appears to be essential. For longleaf seeding, the greatest value of disking is its insurance against serious drought losses in the first year. However, the Crosby Chemicals Company at DeRidder has demonstrated that its method of double-disking increases the early growth of longleaf where the brownspot needle blight is not heavy. The company now has 3-year-old seedlings out of the grass stage and 2 to 4 feet high. This cannot be done by seeding on unprepared sites, and few planted stands ever attain this rate of early growth.

The principal disadvantage of seeding on disked soil is the effect of climatic extremes during germination. Disked soils, like burned ones, dry out quickly when .rainfall is scant, and at the other extreme disking interferes with surface drainage and the sites tend to flood when rainfall is excessive. Landowners interested in seeding longleaf should start with broadcast seeding on a light rough, then adopt the disking treatment if it appears essential for survival on their sites.

Seed

Fresh seed was prescribed in our earlier recommendations for longleaf seeding. This prescription resulted mainly from some unsuccessful trials with stored seed and from the experience of nurserymen who were having difficulty in storing longleaf seed for as long as one year.

To exploit longleaf's periodic seed crops fully, a successful storage technique is needed. We have several tests of seed storage under way, and seed research has been intensified elsewhere in the South, too. This past season nearly 5, 000 pounds of properly stored 1-year-old seed were used for direct seeding in Louisiana. Preliminary observations in January 1957 indicated that the stored seed germinated as well under field conditions as did fresh seed from the 1956 crop. Additional work is needed to determine the effect of seed year, collection date, extraction methods, etc. on keeping qualities. But progress has been made, and it appears now that fresh seed is not essential, provided the seed used has been properly stored.

Rate and Date of Seeding

Two other recommendations, made before we had effective repellents, need reexamination in the light of recent developments.

Now that seed losses can be controlled, you may ask, why not reduce the amount of seed per acre? That is a good possibility, but until we can demonstrate that we have excessive seedlings from 3 pounds of seed per acre we should continue to use that amount. There are other limiting factors besides the creatures that fly, walk, or crawl. Adverse weather during germination or in the first summer can reduce stocking, and as more of the poorer sites are seeded, higher initial stocking will be needed to insure a stand.

It was formerly considered essential to seed as early in November as possible. This recommendation was dictated by the migration and feeding habits of birds. It permitted germination before bird pressure became severe. Now, later seeding is possible and often desirable, because in late November and early December we normally have the best weather for germination.

Seed Treatment

Chemical formulations are now available that will either repel or eliminate most animals, afoot or awing, that have an appetite for pine seed. With longleaf we are mainly concerned with birds and for them a repellent is most desirable. The best repellents we have at the present time are sublimed anthraquinone, Arasan-75, and Arasan. Other anthraquinones are effective, but are not so widely available. The Arasan compounds have some rodent repellency and, therefore, may be superior to the anthraquinones. Arasan-75 and Arasan should be applied to longleaf seed at the rate of 15 percent by weight (15 pounds per 100 pounds of seed). Sublimed anthraquinone, which is far less irritating to the eyes and skin than Arasan, should be applied in a 25 percent dosage. All these repellents are applied as an overcoating after the seed is immersed in a 25 percent mixture of asphalt emulsion in water. The asphalt emulsion serves as a sticker, and the most effective one tested so far is a product manufactured by Flintkote, called C-13-HPC.

A continuing program of testing repellents is under way at Alexandria in cooperation with the Denver Laboratory of the U. S. Fish and Wildlife Service. The Laboratory has assigned a man to Alexandria to work on the problem of controlling bird depredations in forest regeneration. He is also working, with others in his Service, on the rodent hazard, which in the South is most acute during the spring months when we are seeding slash or loblolly pine.

Seeding

Several methods of distributing seed can be used. The choice depends on the size of the seeding project, site treatment, topography, and in some cases the seed treatment. For small or irregular areas, seeding with hand-operated or tractor-mounted Cyclone seeders works well. Hand seeders are inexpensive, and can be used for a labor cost of approximately 50 cents per acre. They require a man to walk a half mile for each acre seeded, which limits their use on large areas. Seed treated with irritating or toxic chemicals cannot be used in them because the operator is constantly exposed to the chemical dust.

Seeding on disked strips can be done by hand or with tractor-mounted seeders. Strip seeding requires more than getting the right amount of seed on the disked soil. The seed must be firmed into a stable portion of the strip. Therefore, strip seeding requires machines built for that purpose -- such as those Crosby has been using successfully for the past 5 years.

During the past 2 seasons airplane seeding has been developed to the point where it is as accurate as any other method. Several earlier trials were disappointing because of inaccuracies in the sowing rate. In 1955, Louisiana Flyers, Inc. , at Lake Charles, La. , agreed to try a modification of the conventional seed distributor on a light plane. This modification changed the long narrow opening in the seed hopper to 3 smaller rectangular openings that permitted longleaf seed to flow out at a uniform rate. Since then this firm has seeded several thousand acres with high accuracy. The work also demonstrated that seeding can be done rapidly with a light plane capable of carrying about 120 pounds of seed.

Especially with a light plane it is desirable to have a landing strip available on or near the area for greatest efficiency. Several landowners have graded dirt strips in the center of the area to be seeded, and the cost is largely defrayed by a lower charge for seeding. The cost of aerial seeding during the past season ranged between $0. 50 and $0. 88 per acre, depending on the size of the project and the proximity of a landing strip. (These costs are for seeding only, and do not include supervision or the labor required to load and flag the plane.)

Evaluation

The success or failure of a seeding project is relatively easy to determine. Stocking can be estimated from a regular milacre-plot inventory made during March or April of the first season. A reexamination after the first summer is also necessary to measure the extent of summer mortality.

Finding the cause for failure is often a difficult task. Although birds have been the principal problem in longleaf seeding, other biological agents will cause trouble in certain areas. Unusual numbers of town ants, raccoons, or rabbits can reduce stocking severely. Climatic conditions or poor seed quality may be responsible for some failures. Therefore, we urge foresters who are seeding to examine their areas frequently during the germination period, and to install special observation plots where they can detect any unusual damage to seed or seedlings.

It is timely here to mention the effects of grazing. At present the interest in seeding has outstripped the landowner's willingness to fence. Consequently, some seeding has been done under open range conditions and we are watching these areas with interest. Grazing damage caused the failure of several large seeding projects in the past. The best seeded longleaf stand6 today are on areas that were protected from grazing at least for the first few years. Usually, grazing damage occurs slowly over an entire season, and may easily go unnoticed until heavy losses have been sustained. Therefore, we can only point to the contrast between grazed and ungrazed areas as the best argument for protecting seeded areas from grazing until height growth starts.

CONCLUSION

Through the combined efforts of research foresters, biologists, and landowners, direct seeding has been developed into a reliable means of regenerating long leaf pine. Although some of the difficult problems are behind us, others remain. Rodents, for example, have been discounted as of minor importance in fall seeding. We are learning, however, that their populations build up rapidly during the winter. In recent tests, serious seedling losses were incurred during a short period in January. We are not sure that rodents were responsible. If they were, some method of control must be worked out for is to get optimum stocking from our seed supply.

The demand for longleaf seed will probably exceed the supply for several years to come. We feel sure, however, that if direct seeding creates a steady demand for seed, collectors will have the incentive to set up the facilities needed for handling cones and seed in large quantities.