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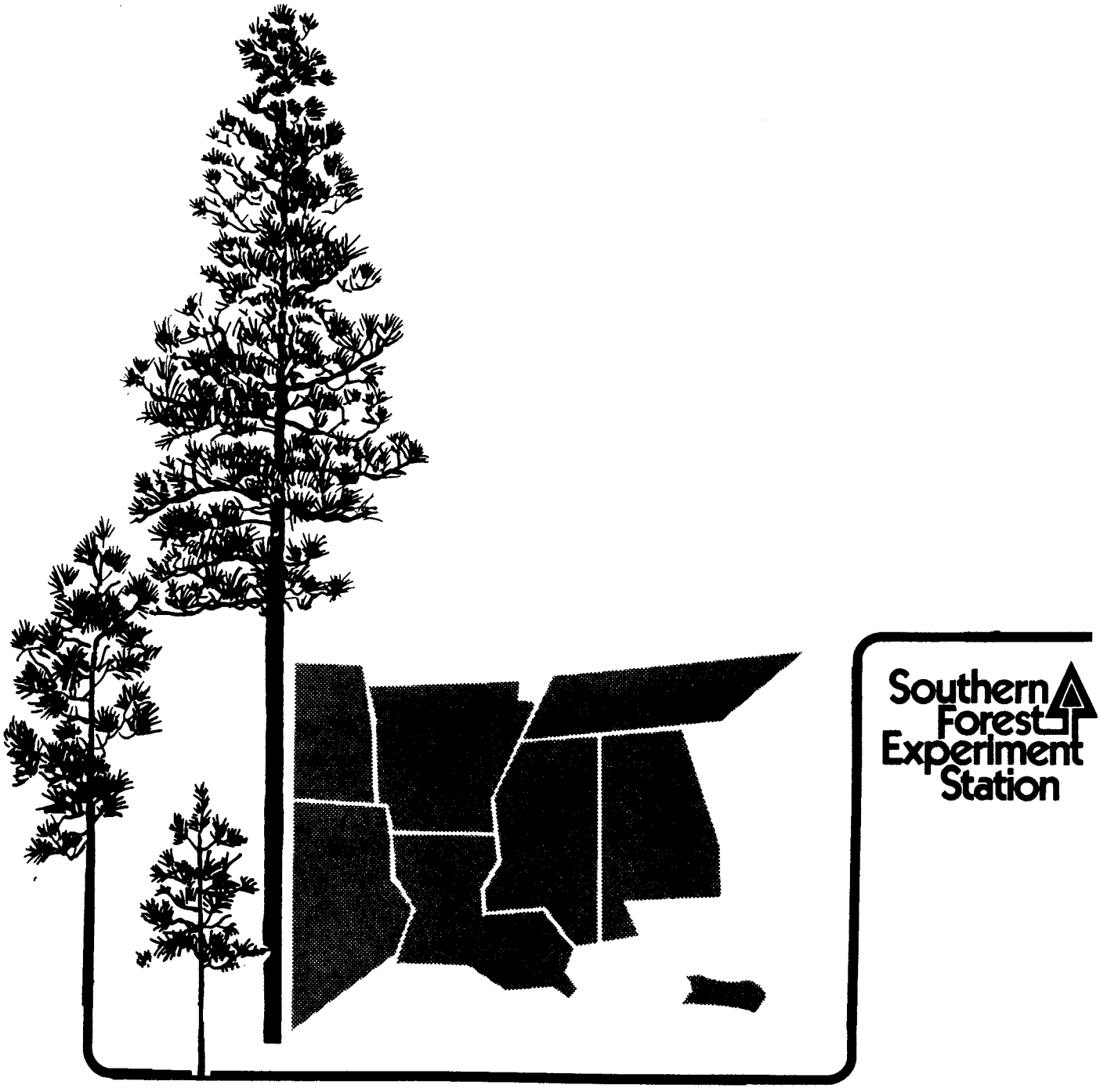

DIRECT SEEDING OF SOUTHERN OAKS--A PROGRESS REPORT

Robert L. Johnson and Roger M. Krinard[1]

Since 1981 over 4,000 acres of publicly and privately owned land, mostly in flood plains, have been direct seeded with acorns. Most seedings have been in abandoned farm land, the rest in forest openings created by commercial tree harvest. Cost data associated with a few of the production trials are presented in this paper. Also included are discussions of production methodology developed for direct seeding by land managers using information gathered through research on collection and storage of acorns, depth and timing of sowing, rodent damage, germination, seedling growth, and competition.

Research Findings

Oak seeding research began at the Stoneville, Mississippi, Southern Hardwoods Laboratory in the early 1960's. Initial trials were conducted in bottomland forests under a complete canopy and in openings of <0.01 acre created by removing a single large tree; they were generally failures due to rodent damage. Acorns were treated with several different potential repellents, but none were effective. In 1969 Nuttall oak (Quercus nuttallii Palmer) acorns were sown in three different-sized forest openings--rectangles of 20 by 90 feet and 40 by 90 feet, and squares of 250 by 250 feet. Rodent damage was considerably less in the largest openings, providing a clue that opening size could be an important variable in the success or failure of oak seeding. Further research has generally substantiated a high rate of success in complete openings >100 feet on a side.

Slow growth of direct-seeded Nuttall oak through 5 years was discouraging in an early test because competing sprouts and seedlings of several tree species outgrew the oaks. But 10 to 15 years later on the same area enough oaks had developed into a competitive crown position to assure their presence in the future sawtimber stand.

Of the species that usually compete with oaks, yellow-poplar (Liriodendron tulipifera L.), is the most formidable when it occurs on a good site and in dense stands of 1,000 or more trees/acre. Cherrybark (Q. falcata var. pagodifolia Ell.), water (Q. nigra L.), and Shumard (Q. shumardii Buckl.) oaks are usually recommended for direct seeding on good yellow-poplar sites such as the silty uplands.

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Seeds sown 1 to 6 inches deep will germinate and produce seedlings, but there is little advantage to sowing acorns deeper than 4 inches. Even at the 6-inch depth, acorns are susceptible to rodents, and seedling establishment has been reduced in some tests due to rodent damage. Because the temperature-moisture conditions in the surface 2 inches can be extreme on clay soils, sowing at a depth between 2 and 4 inches may be best.

Water, cherrybark, Shumard, and Nuttall oak acorns can be removed from cold storage and sown during the summer with good results. Seeds that germinate during storage will produce seedlings when field-sown even if their radicals are broken (Bonner 1982). Nuttall oak acorns can be sown any month of the year (Table 1) even though germination seems to be higher for winter-sown acorns. There are advantages to sowing acorns soon after collection; one advantage may be that acorns are less attractive to rodents. We theorize that, compared to stored acorns, newly collected acorns do not exude odors that are so attractive to rodents. Early seeding also eliminates long-term storage that would require cold storage conditions and monitoring of the seed. The least desirable period for sowing in the deep South is usually July through October, when the soil is normally hot and dry. Occasional acorns sown during July and August will remain dormant and overwinter before germinating the following spring. However, acorns of site-suitable species sown in overflow areas soon after the water recedes, which usually occurs in April, May, or June, should germinate and produce healthy seedlings.

Table 1. Percent germination for Nuttall oak acorns collected in October 1984 and sown at two planting depths in Panther Swamp NWR, Mississippi.

Date sown	Depth of sowing	
	2 inches	6 inches
10/12/84	80	78
11/5/84	92	84
12/11/84	77	73
1/5/85	71	61
2/13/85	67	60
3/5/85	74	61
4/8/85	77	67
5/8/85	67	69
6/11/85	69	53
7/1/85	65	49
8/5/85	64	64
9/10/85	53	55
10/15/85	63	46
11/12/85	65	53
12/10/85	68	47

Most acorns are collected after falling to the ground. Depending on species they mature and fall in the South between late September and mid-January. Acorn size and quality varies among parent trees but both are fairly consistent from seed crop to seed crop for an individual tree. Defective acorns drop first. Compared to good acorns, they may have weevil holes, or be still in caps, faded or light brown in color, and lighter in weight. Under each seed tree 5 to 10 apparently good acorns should be cut in half and checked for soundness before the crop is collected.

After acorns are collected and brought in for storage, they should be given a float test. Defective acorns float in water, good acorns sink. However, extremely small acorns may float even when they are sound and viable so a few floaters should be cut and checked for soundness. Eliminating as many bad acorns as possible pays; fewer acorns have to be handled, stored, and sown to achieve the desired number of seedlings.

Acorns of the red oak species group can be stored for up to 5 years in 4-mil thick polyethylene bags at 35 to 40 °F (Bonner 1973). It is advisable to sample stored acorns every month or two to check moisture content and germination. If moisture contents of sample acorns fall below 35 percent based on oven-dry weight, stored acorns should be soaked in water at room temperature for 2 or 3 hours. Quick germination tests can be run on acorns by removing their pericarp and placing them in a germinator set for 80 to 90 °F. Most acorns so prepared should germinate within 5 to 10 days. Light is not necessary.

As a general rule, acorns of white oak species cannot be stored for more than 3 or 4 months. Rink and Williams (1984) suggest that acorns of one white oak (Q. alba L.) be stored in 1.75-mil polyethylene bags instead of the 4-mil bags used for red oak acorns. This is to allow for greater gas exchange and to reduce the buildup of CO_2.

Collection and Seeding Programs

The largest ongoing oak seeding program is that of the Louisiana Department of Wildlife and Fisheries. This group, led by Larry Savage, has already seeded over 1,000 acres of old fields in the Ouachita Wildlife Management Area near Monroe, Louisiana, and plans to seed at least 3,000 more acres.

Of the many different red oak species direct seeded Nuttall oak has been the most popular. Other red oaks used include cherrybark, laurel (Q. laurifolia Michx.), Shumard, southern red (Q. falcata Michx.), water, and willow (Q. phellos L.). White, overcup (Q. lyrata Walt.), sawtooth (Q. acutissima Carruth.), and swamp chestnut (Q. michauxii Nutt.) oaks have also been tried.

Acorn Collection

According to most land managers, acquiring acorns for direct seeding is one of the biggest jobs. Collecting is usually done in the South between October 1 and January 31. But acorns in the forest may be

devoured by birds and animals within 2 to 3 weeks after they drop and the time when the acorns fall from the trees varies by species and individuals within a species. Although acorns are available longer during years of very good seed crops, many oaks will produce really good crops only 1 year in perhaps 4 or 5. Thus, for storable red oak acorns, extra collecting may be required in good years to offset poor years. Acorn storage can be expensive, but the overall cost is small compared to what would be spent trying to collect a sufficient number of acorns during poor crop years. More important, storage may allow for an annual seeding program instead of a seed-when-you-can approach.

Louisiana Department of Wildlife and Fisheries personnel collected 16,744 pounds of acorns during the 2-year, 1984-1985 period. About half that total was Nuttall oak collected in 1984. When acorns are plentiful, the Louisiana personnel estimate that one person may collect about 1,100 acorns per hour. Maximum hourly collection rates per person may be 8 pounds of small acorns (about 3,200 acorns) such as those of water and willow oaks, and 25 pounds of large acorns (perhaps 2,500 acorns) such as those of Nuttall or Shumard oaks.

Louisiana personnel estimate the per acre cost of acorn collection at about $20.00. This total includes an average of $85.00 per man-day for salary plus expenses. It also assumes only 5 hours of actual collecting time in an 8-hour work day. Acorns can be purchased, according to several land managers, for $0.50 to $1.50 per pound for large acorns and $0.50 to $3.50 per pound for small ones. But there is a limited source for purchasing acorns, and if large quantities are needed, an independent group of suppliers should be found.

Acorn Storage

The practical time limit for storing large quantities of red oak acorns may be somewhat less than the 5 years indicated from research. In Louisiana, 5,300 pounds of Nuttall oak acorns were put in an 8- by 10-foot cooler after the fall-winter 1984-85 collection; these provided for direct seeding in 1985, 1986, and 1987 (about 30 months of cold storage). For ease of handling, polyethylene bags contained 20 to 25 pounds of seeds. Bags were stored on shelves, not on the floor, to allow for air circulation. Bags should be on wire shelves as opposed to wood or other solid material because weevils will emerge from stored acorns and eat the bottoms out of plastic bags. If wire shelves are used, the weevils will fall through openings in the wire shelves and the damage to the bags will be less severe. A good bag labeling system, showing species, collection date and location, and percent soundness, is important in storing large quantities of acorns so that the oldest seed is used first. Estimates of storage costs vary from $0.50 to $2.00 per acre.

Seeding

Old fields have been machine sown without site preparation, with burning of the herbaceous cover, with a single disking, and with cross disking plus soil pulverizing. The latter is used to reduce stubble and particularly to smooth ruts left by tractors and combines during the last crop harvest. Disking may also help to reduce competing vegetation the

first growing season. Seeding is easier and generally better done on intensively prepared sites, but the cost of site preparation may be up to $15.00 per acre. Essentially no site preparation is done in fields to be hand-seeded.

Mechanical seeders cannot operate in forest openings created by overstory harvest because of too much debris and too many stumps. In most openings all trees $\geq$2 inches in d.b.h. would be cut or sheared, but no attempt would be made to remove tops, disturb the soil, or fill in ruts left by harvesting equipment.

The machines used for planting are actually modified soybean planters. These machines have provided an efficient way of seeding old fields. Both 1- and 2-row machines are used; some will drop acorns automatically, but if a hopper jams long stretches may be left unseeded. Therefore machines are usually manned by one or two people who drop acorns 3 to 5 feet apart within rows spaced 10 to 12 feet apart. In Louisiana, a crew of nine people--three tractor drivers, five seeders, and a coordinator--sow 90 to 100 acres in an 8-hour day at an estimated cost of $15.00 per acre for labor and equipment. Another land manager, Larry Moore of the Tensas NWR, Louisiana, has reported machine planting of 40 acres in 6 hours, using a tractor driver and two people on the planter, at an estimated cost of $6.00 to $8.00 per acre.

Forest openings 5 to 20 acres in size have been seeded by hand. On the Delta National Forest in Mississippi, several people spaced about 11 feet apart walked parallel to each other across forest openings sowing acorns at approximately 4-foot intervals. No acorns were sown closer than 5 feet to 4- to 12-inch diameter stumps nor under piles of logging debris. Still, the 800 to 950 acorns sown per acre were usually fairly well distributed. Total cost of seed, sowing, equipment, and supervision was estimated at about $45.00 per acre.

Most land managers have not attempted to control weeds around direct seeded oaks in old fields. However, in a few research trials, bushhogging between direct seeded rows of seedlings appeared to improve seedling survival and growth. In one research test where a forested site had been intensively prepared by shearing residual trees and pushing debris to the perimeter, a bushhog was run between seeded rows after years 1, 3, 5, and 10. There was still a lot of competing vegetation within the rows, but the area had the appearance of a plantation. The reduced side competition appeared to favor oak development (Johnson 1981). Other than this one experience, there have been no attempts at competition control in natural stand openings until free-to-grow oaks reached 15 to 20 feet tall. On a site with an 80- to 90-foot index, under natural conditions, this height should be reached in 10 to 15 years, at which time individual oaks can be released, if necessary, by deadening or cutting competing trees. Earlier release could cause the stand to revert back to a vine stage or allow sprouts from stumps of cut competitors to regain dominance over the oaks.

Over 80 percent of the sown acorns were able to establish seedlings in some research trials. However, 35 percent seems to be a fairly reliable planning figure for commercial sowings. Thus 700 to 1,000 acorns sown per acre should result in 250 to 350 1-year-old trees, an ample number for most objectives.

Total cost to achieve the above stocking may range between $12.00 and $50.00 per acre. Acorns, the labor to sow them, and site preparation (if any) are major cost variables. Based on limited data it appears that seedlings can be established (alive after 1 year) by direct seeding at one-third to one-half the cost of planting seedlings. However, there are so many influencing factors that reliable cost comparisons would involve a thorough economic analysis. There are also practical operational considerations that favor direct seeding. For example, to ensure a given quantity of plantable trees of a given species, a land manager may have to collect acorns for the nursery crop and still pay for seedlings. Machine planting seedlings in old fields is far less expensive than hand planting, but bottomland soils are either too wet or too dry during much of the short planting season to use the machines. Cost data for hand planting seedlings in forest openings are unavailable. Given the roots and debris that remain after tree harvest, planting seedlings is likely to be a labor intensive, and therefore costly, endeavor compared to seeding.

When Direct Seeding Fails

Most direct seeding failures are due to an adverse field environment. For example, free water coupled with high temperature creates a deadly combination for newly germinated acorns. The most destructive free water-high temperature events occur during May or June flooding. These may follow a dry March and April that had been conducive to acorn germination. In one trial, we encountered flooding and high temperature in April; acorns sown in February and those sown in April were not in a critical stage of germination and thus were not damaged. Acorns sown in March had just begun to germinate and they were killed. Where there is likely to be extended flooding during the growing season, acorns should be kept in cold storage and then sown after summer flood waters recede.

Extended periods of drought during the growing season lowers seedling establishment compared to establishment during periods of normal rainfall. But droughts during May, June, and even July may not kill most acorns sown during these months, only delay them from establishing seedlings until there is ample soil moisture. Most established oak seedlings will survive at least 6 to 8 rainless weeks during the growing season.

Less than 5 percent of sown acorns produced seedlings in two old fields where milo had grown the year before. We suspect that a chemical used for weed control may have killed the germinating seeds, especially since leaves of the new seedlings that did appear were chlorotic. Assessing the potential residual effect of chemicals previously applied to a proposed seeding area would be prudent.

Acorn sources may have an impact on seedling establishment. A group of unusually large acorns from a single water oak parent tree were sown in an old field in February. Acorns from other water oak parent trees were sown at the same time. Based on initial cutting and germination tests, acorns from all parent trees were viable. Sample acorns from each parent tree were removed biweekly from the field and tested for germination under laboratory conditions. In mid-April the large acorns were rotten; all subsequent samples of large acorns were also dead. Essentially none of

the large test acorns produced seedlings, whereas under the same environment over half the acorns from other parent water oaks developed into seedlings. We think that the sudden demise of the large acorns was due to some genetic or physiological characteristic (Johnson and Krinard 1985). Thus sowing a mixture of seeds from several parent trees is recommended.

Animals, especially raccoons, are sometimes a problem, both in old fields and large forest openings. But animal damage to field-sown acorns has been severe mainly when acorns were sown where there was a complete forest canopy.

Defective acorns and improper storage techniques that result in acorn mortality will cause direct seeding failures. But there are ample guidelines to prevent either of these problems from happening.

Literature Cited

Bonner, F. T. 1973. Storing red oak acorns. Tree Plant. Notes 24(3): 12-13.

Bonner, F. T. 1982. The effect of damaged radicles of presprouted red oak acorns on seedling production. Tree Plant. Notes 33(4): 13-15.

Johnson, R. L. 1981. Oak seeding--it can work. South. J. Appl. For. 5(1): 28-33.

Johnson, Robert L., and Roger M. Krinard. 1985. Oak seeding on an adverse field site. USDA For. Serv. Res. Note SO-319, 4 p. South. For. Exp. Stn., New Orleans, LA.

Rink, George, and Robert D. Williams. 1984. Storage technique affects white oak acorn viability. Tree Plant. Notes 35(1): 3-5.