Plantation Success in the Harvard Forest as Related to Planting Site and Cleaning, 1907-1947

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DETAILED studies of all forest plantations in the Harvard Forest at Petersham in central Massachusetts provide information on the factors affecting successful establishment of the planted species. Much of the variation in success can be attributed both to the nature of the planting site and the amount of cleaning carried out on volunteer hardwoods.

The present paper is based upon an analysis of all 125 cases of conifer plantings made between 1907 and 1937. Detailed case histories of several of the more important stands have been published by Lutz and Cline,[2] and single-page case histories of many plantations have been compiled by the author.[3]

The 125 softwood plantings in the Harvard Forest range in size from slightly less than one-half acre to 44 acres. They may be subdivided according to whether the planting was done: (1) on open land of old fields or pastures, (2) on semi-open land of old fields or pastures, (3) after the cutting of pioneer hardwoods on old fields, (4) after the cutting of white pine or pine—hardwood mixtures, and (5) after the cutting of transition hardwoods. The early plantings from 1907 through 1917 (58 acres) were largely on open (32 acres) and semi-open (18 acres) land. During the second decade, planting was distributed fairly uniformly between the different conditions and totalled 143 acres. From 1928 through 1937, emphasis was placed on planting following the clearcutting of pine and pine—hardwood types (169 out of a total of 195 acres). Approximately one-half of the total acreage of plantations was set out during this period.

In the vast majority of cases, 2-1 or 2-2 transplant stock has been used. Plantings of seedling stock in general have shown much poorer competitive ability against hardwoods and have been less successful than those set out with transplants.

Considerable effort was made prior to the 1938 hurricane to bring the planted conifers through against the competition of overtopping hardwoods. The cleaning operations were largely carried on with machetes and axes. No chemical treatments are included in the present discussion which is based upon experimental records of the entire forest up to 1950.

Open Land

On all counts, the most successful plantations have been those established on open land. Without exception the planted species have come through to make up the entire new stand. Very little cleaning (also termed weeding or release cutting has been needed. Only 17 of the 30 plantations on open land have been cleaned at all, and these have required an average of only 3½ man-hours of work per acre, largely to prevent the encroachment of hardwoods along the old fence rows or stone walls. All but one of these plantations are on well drained glacial till (Gloucester soil).

Of the various species planted on open land, red pine, Norway spruce, and white spruce have done the best. White pine has shown less growth than red pine and the spruces and, in addition, has been seriously deformed by the white pine weevil under practically all conditions. Spruce — white pine mixtures have proven unsatisfactory because of the weeviling of the pine which has a faster early height growth than the spruce, even though the spruce eventually becomes taller. Spruce—red pine mixtures, on the other hand, have proven among the best, as much of the spruce gradually drops out, giving the red pine a much needed thinning at a time when felling operations are uneconomical. Plantations of ponderosa pine and Scotch pine tend to deteriorate in their middle years, possibly as a result of trees of an unsuitable seed source having been planted.

Semi-Open Lands

Where old fields and pastures with a scattered advance growth of gray birch, pin cherry, aspen, sumac, white pine, and other pioneer species have been planted, the results have been highly successful. The only outright failures have been attempts to establish white spruce on excessively drained sands, a failure due to inability of the species to survive under adverse site conditions rather than to hardwood competition. Scotch pine and red pine on the same site, however, have survived and grown adequately. More than 24 man-hours of weeding over the years were needed in only one plantation, a white pine plantation on a sandy outwash plain where the gray birch was left as an overstory until 12 years after planting. Omitting these five plantations on outwash sands, the remaining 19 plantations of semi-open land with glacial till soils required an average of 2½ cleanings each, taking a total of 11 man-hours per acre. With the exception of occasional areas of imperfectly drained land within the plantations, the planted species came through well. Red pine—spruce mixtures have grown better

[1]Based upon work carried on as a member of the staff of the Harvard Forest, 1940-1950, and derived from a doctoral dissertation submitted to Yale University, 1950.

[2]Lutz, Russell J., and A. C. Cline. Results of the first thirty years of experimentation in silviculture in the Harvard Forest, 1908-1938. Part I. Harvard Forest Bul. 23. 182 pp. 1947.

[3]Spurr, Stephen H. Cases in silvicultural history. Offset. Harvard Forest, Petersham, Mass. 16 pp. + 10 pp. added in 1947. 1944

than comparable pure red pine or pure spruce. White pine and white spruce have also proven reasonably satisfactory on these sites.

Clearcut Pioneer Hardwood Lands

The third group of softwood plantings consist of cases where the gray birch and other pioneer hardwoods on old fieldls had become so thoroughly established that they had to be clearcut before the area could be planted. These thirteen plantations were put in between 1917 and 1925. In all but two instances, the planted species were brought through successfully with an average of 4.4 cleanings totalling 27 man-hours per acre. Failures were experienced when white spruce was planted on excessively drained sand without cutting the gray birch overstory before planting, and when white spruce was planted on imperfectly drained soil. Red pine required the least amount of cleaning (15 man-hours per acre), while other species were less successfully brought through regardless of the amount of cleaning.

Clearcut White Pine Lands

Where large blocks of trees have been planted on cutover white pine and pine—hardwood areas, success is apparently conditioned by the species planted, site, and amount of cleaning. Red pine has been by far the most successful species. In 9 plantations set out prior to 1936, red pine has come through in all instances requiring an average of only 16 man-hours per acre of cleaning throughout the period. White pine has been less successful. Two early plantations on sandy soils have prospered with only 11 and 14 man-hours of weeding respectively. In six cases on glacial tills, from 40 to 90 percent of the white pine has come through with 18 man-hours of cleaning per acre, but hardwoods still occupy up to half the stand. In another nine cases, white pine has largely failed despite cleanings up to 15 man-hours per acre. It is estimated that 3 to 5 cleanings, totalling 40 man-hours per acre are necessary to bring planted white pine through on cutover old field white pine or pine—hardwood stands. Of the older Norway spruce plantations on these sites, two have come through with 11 and 27 man-hours of cleaning, respectively, but one has failed despite 26 man-hours per acre.

Efforts to improve stocking by supplementary plantings of cutover white pine lands have been unsuccessful and have been abandoned (Lutz and Cline[4]).

Clearcut Transition Hardwood Lands

The final group of plantations consists of 17 stands planted following the clearcutting of transition hardwoods. In these cases, hardwood competition, largely in the form of stump and seedling sprouts, has been excessive. Nevertheless, the red pine plantations have been very largely successful when cleaned repeatedly. The six best red pine plantations have required 4 or 5 cleanings totalling an average of 25 man-hours per acre.

White pine has been largely unsuccessful on cutover hardwood lands. In the most successful plantation, only one-half of the present stand is now white pine despite 31 man-hours of cleaning per acre. The other cases are failures, with cleanings ranging up to 22 man-hours per acre. The above plantations are all on well drained glacial till. One plantation is on very well drained stratified drift. Here, the red pine and the European larch have done well, while the white pine and Norway spruce have failed.

Discussion

From the above analysis of all softwood plantations in the study area, a fairly clear picture emerges of the extent to which planting has changed forest composition. All plantations on open and semi-open land have been successful. Red pine, Norway spruce, and white spruce have been the most satisfactory species on these sites.

On cutover land, planting site is most important. Few, if any, plantations on imperfectly drained land have survived hardwood competition. On excessively drained sites, only red pine, and possibly Scotch pine and European larch have proved capable of consistently taking over the area, with white pine and Norway spruce proving successful only under conditions of less extreme drought and infertility. Most of the plantations on cutover land have been put out on well drained uplands (Gloucester, Brookfield, and Charlton soils). Cleaning is necessary in all instances. Red pine is the most successful species, requiring 15-16 man-hours of cleaning per acre on cutover pioneer hardwood, white pine, and pine—hardwood lands, and around 25 man-hours per acre on cutover transition hardwood lands. Also successful are the exotic larches. Because European larch is almost invariably killed by porcupine girdling, however, only the Japanese larch, Dahurian larch, and possibly Dunkeld larch can be brought through to maturity. White pine can be brought through only by intensive cleaning. On cutover lands of all types on glacial till, probably 40 man-hours per acre distributed among 4 to 5 operations at intervals of several years are necessary to bring this species through. Less definitive information is available concerning Norway spruce and white spruce. Neither is successful on imperfectly drained soils or on excessively drained sands. On well drained glacial till, both form good plantations. Their slowness in height growth during early years, however, make many cleanings necessary when they are planted on cutover land. Apparently these species will require more cleaning than red pine but less than white pine.

In summary, red pine seems to be by far the best plantation species in central New England, forming successful plantations with a minimum of cultural work on a wide variety of sites. If mixed with Norway or white spruce, thinning operations can be delayed because of the natural thinning resulting from the gradual suppression of the weaker spruces. Both Norway and white spruce will also

[4]Op. cit.

form satisfactory plantations provided the hardwood competition is not too severe. White pine is less satisfactory in that its survival depends upon repeated heavy cleanings, and the quality of the resulting stand is greatly lowered by heavy weevil damage. The Asiatic larches are promising but insufficiently tested. None of the other species planted between 1907 and 1937 can be recommended in the light of present-day knowledge. Modern chemical cleaning techniques may well improve the prospects of success when conifers are planted on natural hardwood soils.

Georgia's New Dewinger

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ANNUALLY the Georgia Forestry Commission uses from 15,000 to 20,000 pounds of pine seed in its four forest tree nurseries. In 1954 it was first realized that equipment used for seed extraction and cleaning damaged the seed. Tests were therefore conducted to determine the effect of equipment on cleaned seed and it was found that the dewinger (Fig. 1) caused from 12 to 15 percent reduction in germination (*4*). Similar injury was also reported by Umland of T.V.A. (*2*), though his test showed the amount of injury to be slightly higher. This reduction in seed germination was attributed to repeated jarring of the seed as it passed through the machine, causing injury to the embryo in some unknown manner. No outward signs of injury such as cracked or scarified seed coats were observed, nor were any mashed seed found which might have internal damage.

Faced with the problem that a loss of several thousand dollars was being incurred annually due to dewinger injury, a study was initiated by the Georgia Forestry Commission in cooperation with the Southeastern Forest Experiment Station[1] to locate or develop a new machine or modify the existing dewinger so as to eliminate or minimize this undesirable effect. The machine described below was found to dewing seed with a minimum of injury.

[1]Forest Service, U. S. Dept. Agric., Asheville, N. C.

Description

The Crippen Model EP-26 polisher shown in Figure 2, was developed as a popcorn polisher. It was designed to remove "bee wings, light chaff, and dirt from shelled popcorn, without damaging the cleaned product" (*1*). Since dewinging pine seed is a similar process, several pounds of uncleaned slash seed were sent to the Crippen Manufacturing Company of Alma, Michigan, for testing purposes. Germination tests (*3*) indicated that seed passed once through the machine suffered no injury. Seed that went through the polisher two or more times showed a slight reduction in germination. In view of the fact that seed passed through the polisher one time were apparently uninjured yet dewinged ade-

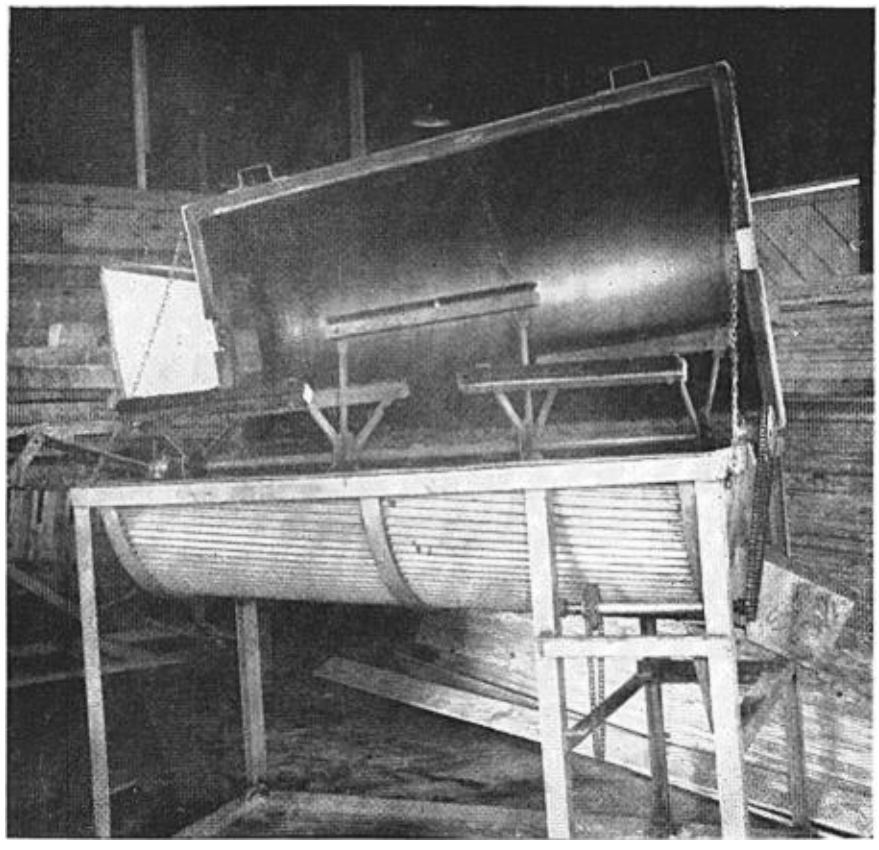

FIG. 1.—Standard Forest Service type dewinger.