SEED PRODUCTION AREAS--A STEP TOWARD BETTER SEED

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Why We Need Seed Production Areas

During the past decade there has been a surge of interest in tree improvement in the United States. To a considerable degree this stems from the realization that a large forestation job faces us. In the north-central United States, for example, almost 17 million acres, about evenly divided between the Lake States and the Central States regions, are plantable (U. S. Forest Service, 1958). It is logical that this area should be planted with the best adapted and most productive planting stock we can grow. Such stock should come from seed with the best available genetic potential.

Eventually much, if not all, of our improved seed will come from seed orchards. It will take time, however, to find the superior trees that must provide the material for the seed orchards and to develop orchards from them. In the meantime seed production areas can provide a valuable first step in providing us with improved seed.

What They Are

By definition a seed production area is "a superior (plus) stand which is upgraded by periodic removal of undesirable trees (roguing) and cultured for early and abundant seed production" (Snyder, 1959). Usually these stands were originally established for purposes other than seed production and are less intensively selected, isolated, tested, and cultured than seed orchards.

A necessary first step is to scout out in each homogeneous region (reasonably uniform in temperature conditions) (Rudolf, 1957) the best stands of all forest tree species to be planted and from them to select a sufficient area to produce the seed required of that species for that region. Ordinarily, rather small areas will be sufficient, and collection should be concentrated on them as soon as they are developed.

In practice the selection of seed production areas may well be by ownerships. For example, the best stands on each national forest, state forest, industrial forest, and comparable area may be selected and developed by the respective owners. It may be advantageous in some instances, however, for two or more owners in a homogeneous region to pool their needs so as to get the best available seed more economically. This practice should be encouraged.

The stands to be used for seed production areas should be not only high quality, but also the right age. They should be old enough to give a good indication of tree quality and adaptability (in case of plantations) and yet young enough to benefit markedly from treatments and to bear seed for a long time. In general terms, stands of young middle age should be preferred. Probably the minimum age for selection should be when commercial seed production begins and the maximum about one-half of rotation age. In the Lake States the ages suggested for the five major species used in reforestation are as shown in the tabulation below (Rudolf, 1959):

	Establish seed production areas between these ages (years)	
	Minimum	Preferred
Red pine	30	50-70
Jack pine	20	30-40
Eastern white pine	25	50-70
White spruce	30	45-60
Black spruce	30	45-60

Occasionally circumstances may make it necessary to use stands older than these suggested ages. It will not pay, ordinarily, to develop them as seed production areas if they exceed three-fourths of rotation age.

Stands used for seed production areas preferably should be even-aged. Furthermore, they should not have been thinned previously unless thinning was done from below. (Records should be available to verify the thinning practices used in the latter instance.)

For those tree species that are not available in good, even-aged, relatively pure stands, seed production areas may be out of the question. (White spruce in much of the Lake States area is in this category.) In those instances seed orchard development may have to be the first step.

How to Develop Them

Each stand selected as seed production area for timber production purposes should contain trees of good vigor, soundness, form, fecundity, branch thickness, and branch angle (Rudolf, 1956). If the seed is intended for shelterbelt, erosion control, wildlife cover, or other nontimber production purposes, other appropriate standards of selection should govern. Here, however, discussion will be limited to seed for timber production purposes.

A logical first step is to determine how much seed production area is needed in each homogeneous region. To make that decision, there must be long-range planting plans that will provide a reasonable estimate of the maximum amount of planting stock required per year. We can estimate the seed production area required to produce 1,000,000 plantable seedlings per year and, from that, the total area required per homogeneous region.

For the Lake States we have developed estimates of the seed-crop trees required to produce an average of 1,000,000 plantable seedlings per year (Table 1). They are based on our knowledge of average seed yield per tree, frequency of average or better cone crops, laboratory germination of the seed, and tree percent, and on the assumption that collections will be

Table 1. Calculation of seed trees required to produce an average of 1,000,000 plantable seedlings per year

Species	Clean seed: Per bushel cones	Clean seed: Per pound	Average cone production per seed tree[1]	Laboratory germination of seed	Tree percent	Average usable seedlings per tree	Average interval between crops 50% or better	Needed per million seedlings per year[2]: Seed trees	Needed per million seedlings per year[2]: Area
	Lb.	No.	Bu.	Pct.	Pct.	No.	Yrs.	No.	Acres
Red pine	.46	52,000	.25	85	65	3,300	3	600	30
White pine	.95	27,000	.76	65	65	8,200	2	240	16
Jack pine	.52	131,000	.44	65	50	9,700	1½	210	4
White spruce	.45	240,000	.48	50	35	9,100	2	220	10
Black spruce	.25	404,000	.11	50	40	2,200	1½	910	22

1/ Based on good seed-year production of 1 bushel of cones for red pine and jack pine, 111 bushels for white spruce, 2 bushels for white pine, bushel for black spruce, and reduced amounts in off-years for all species. Average production is based on 13 years of seed-crop reports for the Lake States and includes only those years for which a crop of 50 percent or better *was* produced.

2/ A safety factor of 2 is included.

made only in those years when 50 percent or more of a full cone crop is produced (Rudolf, 1959). Even when a safety factor of 2 is used to allow for variability in production and in the proportion of the crop that can be harvested from standing trees, this will require only 4 to 30 acres per species.

After the required area has been determined and enough suitable stands have been found to provide that area, three steps should be taken immediately in each selected stand:

1. Choose the best trees in the stand on the basis of vigor, form, crown and branching habit, and seed production.

2. Rogue out all undesirable trees.

3. Give the selected seed-crop trees extra growing space by removing competing trees.

At establishment it will be prudent to select not only the "first stringers," but also a small number of "second stringers" (say 25 percent of the number of the former) to fill in if windthrow, wind breakage, lightning, or other enemies damage some of the "first string" seed-crop trees in the first few years. These extra trees can be removed in the thinnings, which should be made at intervals to keep the crop trees essentially free of competition.

The spacing between crop trees generally should increase as the trees grow older. The ideal stocking is not known. Undoubtedly, it will vary with the species, age of trees, and site conditions. A rule-of-thumb suggested for the Lake States (Rudolf, 1959) is that the average spacing between seed-crop trees should be about one-half the average height of the dominants and codominants (Table 2). This provides automatic adjustment for age and site.

An essential part of a seed production area is an isolation zone to protect the crop trees from pollination by undesirable trees. If the seed production area is part of a larger stand, it should be surrounded by a zone in which only trees of the same caliber as the seed-crop trees are allowed to remain, or in which have been removed all trees of the selected species or others that may cross-pollinate naturally.

It is known that pollen of many tree species may fly long distances. Studies of several conifers in the Northeast and South have shown, however, that the amount of pollen that is dispersed falls off sharply beyond 300 to 400 feet from the seed tree (Wright, 1952). For the Lake States, therefore, we have suggested the same width of isolation zone, at least 400 feet, as is recommended for the South (Georgia Crop Improvement Association, 1958). As research brings to light new information, this recommendation, as well as others in this paper, may be modified.

Table 2. Guide to average spacing and number of trees per acre to leave on seed production areas

Species	Age	Average spacing between trees[1/]	Average trees per acre
	Yrs.	Ft.	No.
Red pine	50	28	56
	70	35	36
	120	46	21
White pine	50	30	48
	70	40	27
	120	53	16
Jack pine	30	16	170
	40	22	89
	60	28	56
White spruce	45	24	76
	60	32	43
	120	43	24
Black spruce	45	18	135
	60	23	83
	120	32	43

1/ Equal to one-half the average height of dominant and codominant trees on medium sites; on poor sites heights will be lower and more trees will be required, while on good sites the reverse will be true.

How to Maintain Them

Once established, seed production areas need maintenance and protection. The major object of maintenance is to give the seed crops full room to develop. An essential practice is thinning at intervals of about 10 years.

Each thinning should favor the best trees. Spacing considerations should be paramount only where choices between trees are equal. In the original and subsequent cuttings, great care should be taken to avoid damage to the crowns of the seed-crop trees. So far as possible, thinnings should be made in years when cone crops are 50 percent or better and when the cones have ripened so that an additional supply of seed can be obtained at a reduced cost.

Further, to give the selected seed-crop trees full access to soil moisture and mineral nutrients, any concentrations of brush or other competing woody plants should be controlled by chemical herbicides, mechanical means, or other effective methods. Such activities can also facilitate fruit harvesting and protection activities.

The seed production areas should be fully protected from fires, especially crown fires. They must also be protected from insect and disease damage so far as possible. This is true not only of those pests that reduce tree vigor, but also of those that injure mainly flowers and fruits. Protection is also required from the activities of squirrels, porcupines, and sometimes other animals that may injure the trees or cut flowers and fruit-bearing twigs.

Seed production areas also need protection from man. Unauthorized fruit collections, for example, must be prevented. The trees should also be protected from unnecessary injury during seed harvest. This can be done by such means as careful training of pickers and use of special equipment. In turn authorized seed harvesters should be protected from injury by encouraging them to understand and apply approved safety practices (Greathouse and Blaser, 1958; Snyder and Rossoll, 1958; U. B. Department of Agriculture, 1958).

How to Improve Them

Providing abundant growing space and reduced competition for the seed-crop trees will increase production per tree. Research in other regions and nations indicate, however, that even further increases can be obtained by employing mineral fertilizers, cultivating the soil, pruning or topping trees, and possibly using other practices (Arnborg, 1956; Mathews and McLean, 1957). Results have been so variable, however, as to indicate that a two-fold program of research is necessary:

1. Basic studies to determine the actual requirements of various species for mineral nutrients and moisture to promote maximum flowering and seed production.

2. Local applied studies to develop the most effective seed production methods for specific local conditions.

Included also should be studies to permit control of flower and seed pests and to provide more exact pollen barrier requirements.

Seed Costs

Experience in the South and the Lake States indicates that the cones from seed production areas will cost about 50 to 100 percent more than those purchased on the open market (Goddard, 1958; Hitt, 1958). Better seed yields per tree may, however, offset part of this increased cost. Furthermore, since seed procurement accounts for only a small part of total nursery stock production costs, the increased seed costs will not add much to the total and should be more than offset by the better quality of the stock obtained (Rudolf, 1959).

The Next Step

Seed production areas are a logical first step in providing better seed, but they are only a first step. They should be developed in the best way we know. Their development should be accompanied by research to determine the effects of such factors on the following on the seed production of our principal species: fertilizers, tree size and class, pruning and topping, hormones and related substances, various ground treatments, injurious treatments (girdling, root-pruning, etc.), irrigation, methods of fruit harvesting, specific insects and diseases, and various animal pests.

Results of much of this research will probably not be available for many years. Most of it, however, will be of equal value for the next step in producing better seed, the development of seed orchards.

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