CONTROLLING THE GENETIC QUALITY OF PLANTING STOCK FROM FOREST TREE NURSERIES

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INTRODUCTION

The most critical decision in the life of a plantation takes place several years before it is planted. That decision is usually made by someone who has never seen and possibly never will see the site. When correct decisions are made, many thousands of acres of forest land are occupied by vigorous, well-adapted trees. When incorrect decisions are made, the same number of acres may fail entirely or, perhaps worse, are occupied for decades by poorly adapted, misshapen, unproductive trees. That decision is what source of seed to plant.

Nurserymen know a great deal about seed quality. While germination rate, purity, stratification requirements, and storage conditions have been studied extensively, nurserymen rarely spend as much time considering the genetic quality of the seed they handle. Still, both are highly important in producing vigorous, well-adapted planting stock.

IMPLEMENTING A GENETIC QUALITY CONTROL PROGRAM

Seed Labeling and Certification

The first, least costly, and perhaps most important step in good genetic quality control is simply proper identification of all seed coming in to the nursery and all seedlings leaving the nursery. This entails including on the tag or shipping label not only the name of the species, but all known information about the origin of the particular seedlot as well.

New York State implemented such a simple system in the 1930s and it has saved us innumerable acres of ruined plantations. In 1946, the State purchased 440 pounds of a particular variety of Norway spruce (*Picea abies* L.) described as a 'rapid growing strain'. It was! But it also exhibited poor survival and worse form. Many of the branches turned up and competed with the main stem, leading to very large limbs. The problem was compounded by the poor survival, which reduced the stocking and delayed crown closure and self pruning. Fortunately, all of the tags leaving the nursery contained the seedlot number so that when the nursery began receiving irate calls about the terrible Norway spruce, they were able to trace it to a specific seedlot and discard the remaining seed. This prevented even more acreage from being tied up or, perhaps worse, the species as a whole receiving such a bad reputation that it was abandoned. There are dozens of similar horror stories about maladapted seed sources.

After this near disaster, New York established some simple seed source tests, selected some reasonably good ones, and now has over 60,000 acres of magnificent source-identified Norway spruce.

New York and many other states have seed labeling laws covering tree seed. Nearly all of them require that seed be source-identified, at least to the level of the county of collection (New York Seed Improvement Cooperative, inc 1984.) If all nurserymen simply made themselves aware of the labeling laws in their respective states, demanded that all purchased seed met at least these minimum standards, and in turn, provided the same information to their customers, we would go a long way toward providing sound genetic quality in our forests.

Seed Zones and Seed Transfer Guides

The next, more sophisticated level of genetic control is the establishment of seed zones and transfer guides.

Every nurserymen knows that there are some species that cannot be grown in a particular region. To cite an extreme example, the Saratoga Nursery in New York State would probably be extremely unsuccessful at growing Caribbean Pine (*Pinus caribaea* Morelet).

In addition to such obvious species differences, there are often similar but more subtle within-species differences. White pine seed collected in Georgia will survive in the Saratoga nursery and can be outplanted around New York, but based on seed source studies, growth and form are extremely poor.

These geographic differences have been examined at a much finer detail in what are called 'provenance tests' or 'seed source studies.' In many regions, the findings from such tests have been incorporated, along with climactic data, into seed zone maps and seed transfer guides (Erickson, Andersson et al. 1980; Rehfeldt 1981).

Correct implementation of either seed zone maps or transfer guides makes more work for the nurserymen. Rather than estimating how many seedlings of a particular species will be in demand in a particular year, nurserymen will have to estimate how many seedlings for each seed zone and, rather than having to deal with only one or two different varieties of a particular species, the nurserymen will have to keep track of as many seedlots as there are seed zones in the region served by the nursery. The return for the extra expense and trouble will come from a premium placed on such seedlings.

Most recent forestry graduates have had at least an introductory course in forest tree genetics and improvement. They will, I hope, realize that insuring the long term productivity of their plantations by using only certified and source-identified seed from the correct seed zones will pay off many times over. I think that nurserymen who address this market and provide certified and source-identified seedlings will find an eager audience willing to pay for the value received.

SEED COLLECTION AREAS

The next, more intensive implementation of genetic quality control for a nursery is to set up seed collection areas. These are simply vigorous, well-established natural stands or plantations of the desired species. These areas are not specifically managed for seed production, nor must they be owned by the nursery. Most land owners will gladly grant the right to collect cones or fruit, especially if seeds can be harvested in a non-destructive manner. They may be considerably less willing if climbing spurs are used or if whole limbs are removed, so seed collection methods must be thought out and explained carefully, in advance, to the land owner.

The characteristics of a good seed collection area are:

1. A reasonable number of trees of the desired species within good cross-pollination range of one another. Ten trees should be a minimum, 25 is better and 100 or more would be ideal. Isolated trees or row-plantings of fewer than 10 trees should be avoided as the seed collected may contain a large number of selfed or inbred seeds which germinate and grow poorly, increasing the cull-rate in the nursery and mortality in plantations.

2. A reasonable distance from stands of related species that are known or suspected to hybridize with the species of interest. Unless you are specifically interested in collecting hybrid seed, it is best to avoid mixed stands of closely related species.

3. Good form and vigor of the majority of trees in the stand. This is especially true of an exotic species. There is no point in collecting from obviously stressed or diseased trees, or from trees exhibiting considerable dieback in the crowns. Often highly stressed trees will flower profusely just before dying. If the cause of stress is not obviously mechanical **ie**: lightning strike, branch girdling, mower or logging injury, it is safest to assume that the stress is caused by genetic maladaptation and to avoid collecting seed from that individual or stand.

SEED PRODUCTION AREAS

Occasionally nurserymen will wish to have a more reliable supply of seed than can be obtained from a stand devoted in seed collection areas, apparently stressed trees should be avoided in collection and should be removed, even if they support large cone crops.

<u>Topping</u>

After going to a lot of trouble to locate stands of above-average quality, it seems insane to purposely destroy the stem form and branch characteristics by severe and/or repeated topping, yet that is probably the best thing that can be done to maintain seed-producing capacity. If trees are well spaced, growing vigorously and have not yet lost their lower branches, even highly shade intolerant species can have the bulk of their crown cut out without killing them. I have cut the top 15 feet out of some 30-foot Japanese larch without killing a single tree. Within three years, the crowns had regrown and were bearing good cone crops at a much more convenient picking height than the uncut controls. The New York State Department of Environmental Conservation has done the same thing in white pine, scotch pine, and white spruce seed orchards and production areas. Topping is a radical treatment and not all species respond well. A few species, again blue spruce being a good example, will take many years to reform a crown and will not flower heavily until they have reached essentially the same height they were before topping. It would be best to contact local tree improvement specialists and see what they recommend. Topping destroys all potential timber use and certainly reduces the aesthetic appearance of the stand. It does not, however, change the genetic quality of the seed produced and it may may drastically reduce costs and risks of cone collecting.

Seed Orchards

Seed orchards are the most visible part of a high-intensity tree improvement program. These are specialized plantings of trees that have been genetically selected to grow faster or straighter, to resist disease, or for some other set of useful traits. The process begins by grafting scion wood from carefully selected outstanding trees, called 'plus trees,' onto seedling rootstocks. The grafts are planted at wide spacings on carefully prepared sites devoted entirely to the production of seed. Site preparation may include stump removal or prime agricultural land purchase, land leveling, deep plowing to remove any hard pans, installation of a permanent irrigation system, and usually the hiring of an orchard supervisor.

Pest management

There are numerous insects that feed on flower buds, cones, or seeds of forest trees. In commercial plantations these are harmless, since most species produce seed in great abundance. Without intensive pest management, it is not at all uncommon to loose 50 to 90% of the cone crop to insect attack. Effective insect-management programs have, however, been implemented for many species (Debarr and Merkel 1971; Miller 1981).

This high-level improvement effort is obviously well beyond the scope of most nurseries and should be undertaken only after extremely careful consideration.

As Dr Bruce Zobel says:

> A tree improvement program must have continuity. **It is a** long-term program and costly. **Either conduct the program correctly, with total support in manpower, facilities, and equipment, or do not do it at all.** Tree improvement does not come free; it is expensive (Zobel and Talbert 1984, p491. Emphasis by the authors).

CHOOSING A GENETIC QUALITY CONTROL STRATEGY

The options described above are listed in increasing order of effort and cost. Deciding among them is not a simple task. A reasonable choice for one species and one nursery may be a poor choice for a neighboring nursery. The major factors that will influence the decision can be divided into two groups:

Economic and marketing factors

1. Regional importance of the species.
2. Current and projected production of the species by the nursery.

Genetic and biological factors

1. Genetic variability of the species (Red pine vs Douglas-fir vs Norway spruce.)
2. Flowering age and seed production characteristics of the species.
3. Seed storage requirements (White oak vs pine or spruce).

Most commercial tree nurseries grow a wide variety of species and could not afford the cost of implementing a high-intensity tree improvement program for a single species, let alone all the species they produce. Instead, they can implement a basic program by growing only source-identified seed and following any available seed zone maps in both their seed procurement and shipping operations.

The next step would be to choose two or three important species and establish seed collection areas or production areas where suitable stands can be located.

Finally, nurserymen can contact regional tree improvement associations, and either join or contract with them to grow seed-orchard seed.

Nurserymen, seed dealers, seed orchard managers, tree improvement specialists, and stand establishment foresters must all work together to insure the genetic quality of the nation's forests.

LITERATURE CITED

Debarr, G. L. and E. P. Merkel. 1971. Mist blower spraying of longleaf pine for cone and seed insect control. USDA Forest Service, Southeastern Forest Experiment Station Research Paper SE-76.

Erickson, G, S. Andersson, V. Eiche, J. Ifver and A. Persson. 1980. Severity index and transfer effects on survival and volume production of Pinus sylvestris in northern Sweden. The Swedish University of Agricultural Sciences, College of Forestry, Uppsala, Sweden. Studia Forestalia Suecica Report No.156.

Miller, G. E. 1981. Strategies for control of insect pests in seed orchards. In. Pollard, D.F.W., D.G. Edwards, and C.W. Yeatman, eds. Proceedings of the Eighteenth Meeting of the Canadian Tree Improvement Association, Part 2, Seed orchards and strategies for tree improvement. Duncan, B.0 August 17-20, 1981. pp. 49-59.

Rehfeldt, G. E. 1981. Seed transfer guidelines for Douglas-fir in Northern Idaho. USDA Forest Service Intermountain Forest and Range Experiment Station, Research Note INT-300.

Zobel, B. and J Talbert. 1984. Applied forest tree improvement. John Wiley and Sons. New York. 505 pp.