THE NEW BRUNSWICK TREE IMPROVEMENT COUNCIL'S BREEDING STRATEGY FOR TAMARACK

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ABSTRACT.--Tamarack (*Larix laricina* (Du Roi) K. Koch), which exhibits rapid juvenile height growth, has the potential to become an important reforestation species. Although there is limited knowledge about the genetics of this species several studies have indicated that variation exists at the geographic, population, and individul tree levels. The New Brunswick Tree Improvement Council has begun a breeding program to improve this species. The breeding stategy adopted is based on the use of several breeding groups. A total of 115 trees has been selected and the first clonal seed orchard established.

INTRODUCTION

Tamarack(Larix laricina (Du Roi) K. Koch) has the widest range of any North American conifer (Roe, 1957). It grows rapidly compared to other native conifers in New Brunswick (MacGillivray, 1969), West Virginia (Cech et al., 1977), and Ontario (Mead, 1978) and is adapted to a wide range of sites, making it a useful species for reforestation (Wile, 1981). Although tamarack has been planted only on a limited scale in the past, it is now receiving attention as a potentially important species for reforestation. Wright (1978) demonstrated that tamarack has great potential as a reforestation species in the Gaspé region of Quebec. In conjunction with its fast height growth, its wood exhibits high specific gravity which makes this species particularly attractive for the production of pulp when grown on a short rotation.

When the New Brunswick Tree Improvement Council (NBTIC) was formed in 1976, tamarack was one of four tree species initially included in the improvement program. The Provincial Department of Natural Resources produces approximately one million tamarack seedlings annually (Bettle and Stinson, 1981) but seed production in natural

stands is unreliable and number of full seed per cone is low. Seedling production is expected to rise when seed orchards begin to produce seed. Presently, there are three other member agencies in NBTIC besides the Provincial Government which plan to establish tamarack seed orchards.

When developing a tree improvement strategy for a species there are three patterns of genetic variation which should be considered: geographic, population, and individual tree variation (Fowler, 1976). Unfortunately there is limited information available about these patterns for tamarack.

Results from a provenance trial planted at two locations in Wisconsin indicated significant differences for survival and height growth among trees from different seed sources, with trees from local seed sources growing the best (Jeffers, 1975). At another provenance trial in West Virginia there were significant differences among seed sources for height growth, with the southern sources growing most rapidly and the northern source growing slowest. This resulted in a significant negative correlation between growth rate and latitude (Cech et al., 1977). Riemenschneider and Jeffers (1980) found a similar relationship existed in the provenance trials in Wisconsin. Rehfeldt (1970) found a clinal pattern of variation for total height, date of bud set, and root development in Wisconsin.

Population studies are currently being conducted at the Maritimes Forest Research Centre. One objective of these studies is to determine the relatedness among neighbouring trees. Early results indicate that trees located within a 59 m radius are related (Park and Fowler, in press). Rehfeldt (1970) concluded that populations and individual trees are genetically highly variable. Individual tree variation, especially for stem straightness and crown form, is readily apparent.

The purpose of this paper is to present the breeding strategy for tamarack which has been adopted by NBTIC and to indicate the progress being made in this program.

BREEDING STRATEGY

The breeding strategy which has been developed (Figure 1) is based on the use of breeding groups proposed by van Buijtenen and Lowe (1979). This strategy involves subdividing the selected trees into groups and not allowing crosses among trees between groups so that the groups remain unrelated. An orchard is established by selecting one or more individuals in each breeding group. All controlled crosses

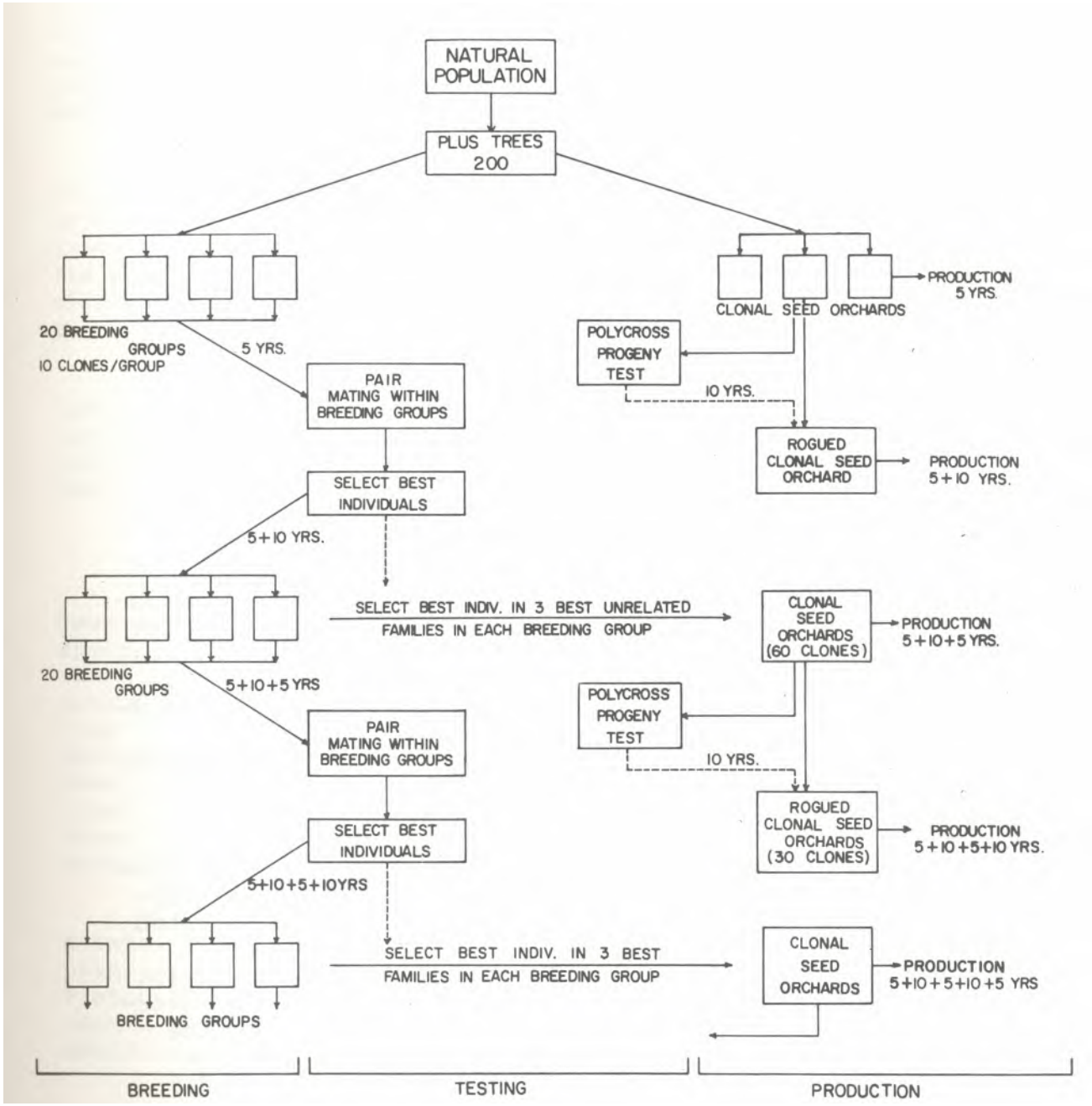

Figure 1. Long-range breeding plan for the improvement of tamarack.

for the purpose of producing advanced generation materials are confined to the breeding groups. The advantages of such a system are that inbreeding is confined within breeding groups and although inbred clones may be used in a production orchard the seed from the orchard will be primarily out-crossed (except for a low level of selfs).

Each first generation clonal seed orchard may not contain all 200 plus-tree selections. Each agency possessing an orchard will conduct a polycross on ramets of each clone and outplant the progeny in replicated tests. The information from the progeny tests will be used to rogue their orchard only. Approximately 50% of the original number of clones will be removed. At the time seed orchards are being established, 20 breeding groups will be set up in the clone bank with each group containing 10 clones representing selected trees from a defined geographic area.

Pair matings will be conducted within each breeding group to produce 10 families. All families from all breeding groups will be planted together in replicated family tests by the agencies involved in the program. Following the analysis of 10-year height measurements the best individual(s) in the best families will be selected to form second generation breeding groups. The selection may be conducted in the following manner depending on family variation within each breeding group. If all 10 families do not differ significantly in performance then the best individual in each family will be selected. If the families are significantly and identifiably different then the best individuals will be chosen from a minimum of five of the best families. When flower production begins, the clones in each breeding group will be mated pairwise to develop new material for the next generation.

Clones for the second generation seed orchards will be selected from the families in each second generation breeding group. The best individual in the three best unrelated families in each breeding group will be selected. Two options may be considered when selecting these individuals. Under the first option, selection will be based on the overall results of the family tests. This will result in the same clones being established in all seed orchards. The second option would involve the establishment of some different clones in each seed orchard based on the performance of the families in the test(s) located in or adjacent to the areas where seed from the seed orchard will be used. Using either option, 60 unrelated clones will be established in each orchard. Results of polycross progeny tests from each orchard will allow 50% of the clones to be culled.

By the third generation it may be necessary to reduce the total number of breeding groups because two cycles of breeding and testing may indicate some groups which have consistently performed poorest. Individuals selected from within each breeding group for the seed orchards will not necessarily be unrelated. Therefore, great care will be needed when designing the seed orchard layout in order to keep two members of the same breeding group separated.

Beyond the second generation it will be impossible to include additional plus trees. Up to this time, all new selections should be tested using open-pollinated progeny tests to identify the better trees and incorporate them into the existing breeding groups as replacements for clones which were removed due to their progeny's poor performance or establish them into one or more new breeding groups.

As with any long-term breeding plan there are many unknown factors. In recognition of this fact, during the implementation of this strategy we plan to remain flexible and anticipate that from time to time it may be necessary to modify the plan.

CURRENT PROGRESS

Plus-tree selection has been continuing since 1977. Tamarack is found in small, often isolated patches. The species is noted for having a notoriously crooked bole which, although we have no heritability data, can likely be improved by selection. In addition, there is large variation in crown form. The comparison tree selection method is used with equal weight placed on stem straightness, crown form, and height growth. We have selected about 115 plus, trees which have been grafted into our clone bank. These trees have approximately 5.5% height advantage over the stand dominants.

The first clonal seed orchard was established in 1982. A total of 600 ramets representing 51 selected trees were planted. A computer designed layout, developed by Bell and Fletcher (1978), was used to determine the placement of ramets. It is anticipated that orchard establishment will continue until the late 1980's.

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