TREE IMPROVEMENT RESEARCH AT THE UNIVERSITY OF MISSOURI: NEED, CURRENT WORK, AND OUTLOOK

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There is in Missouri a stir of interest in the program of tree improvement research that, viewed nationally, has gained an impressive momentum. While foresters in our State are concerned primarily with the expediency of a low-grade marketing problem, we must all now and again come face to face with a moment of truth. Any major and enduring development of forest products industries must follow, not precede, the establishment and maintenance of more suitable forests.

There has been and is a strong conviction that the deterioration of extensive forests in the Missouri Ozarks, for example, can be accounted for 'n terms of degeneration of the forest site. That this is largely so can only be further emphasized here; but the conviction as stated expresses a half-sighted view. It fails to encompass the science of genetics and to recognize that inheritance has a logical role in any well-rounded silviculture thinking.

The degree of decline in the inherent structure of stands that comprise deteriorated forests becomes a question of paramount importance. Repetitious high-grading (a creaming operation that has characterized selective logging as a practice in our deciduous forests) can be an insidious force. Detrimental alterations of the germ plasm are less easily appreciated than the harmful effects of burned acres and eroding slopes. Genetically based injury is, therefore, difficult to appraise.

That a serious decline in the inherent quality of many stands has indeed occurred seems, nevertheless, increasingly clear. Evidence from research continues to substantiate the heritability of such undesirable traits as spiral grain. crook, and heavy branching. One must suppose that our hardwood forests have been especially subject to this kind of deterioration; for it is there, due to a greater range in merchantability, both within and between species, that selective logging has left a large residue of low-quality individuals. In Missouri, however, are also found remnants of once-splendid shortleaf pine forests. Clear cuttings of original pine stands removed all but the most scraggly individuals, which in many instances have served as progenitors of scattered, often sparse present-day stands. Any tiny seedlings or seed in the duff at time of logging frequently had little chance in wake of the subsequent fires.

In brief, what has been said is simply by way of indicating a need for tree improvement research in Missouri. As foresters, our objective should be not merely to restore a quality in our forests on a par with that found in the original stands. As has been the case in other plant crops, a development of the necessary scientific knowledge and materials should ultimately result in stands markedly superior to those found in wild tree populations. It will be the purpose of the rest of this paper to summarize the limited amount of tree improvement research now under way in Missouri and to consider the direction that additional work of this nature should take.

Many of those present may be surprised to learn that most of the Missouri tree improvement work now in progress is an outgrowth of a Christmas tree project. This was a natural development. Although much was learned through studies involving species comparisons, site preparations, fertilization, grades of nursery stock, spacing, shearing, and various protective measures -- observations soon suggested that the best of cultural measures could not assure a good Christmas tree crop.

It became apparent that much of the variability was genetically based. Shearing might be used, for example, in an effort to force a misshapen, crooked-limbed young tree to develop symmetrically, only to have that tree revert to its previous undesirable habit. In other words, some trees needed little if any shearing or pruning to achieve a symmetry and density of crown, while no amount of treatment would bring about these desired results with other trees. Equal measures of variation were found in other factors such as growth rate, stem straightness, angle of branching, and foliage color. While marked differences in survival, growth, winter color, and certain morphological traits have occurred between stocks of different geographical sources, we have been equally impressed by the extreme variations within a source.

We might pause here to consider that Christmas trees provide an excellent crop with which to work in terms of genetical selection. One doesn't have to wait 50 years or more to draw conclusions. Rather, he can appraise his crop in the relatively short rotation period of 3 to 7 or, at the most, 10 years, depending on species.

Based on the above considerations, we began to experiment with geographical races, to make individual tree selections, and to conduct 1-parent and 2-parent progeny tests. While this work has been primarily with jack pine (Pinus banksiana Lamb.), studies of appreciable scope are also under way with Scotch pine (Pinus sylvestris L.), Douglasfir (Pseudotsuga menziesii (Mirb.) Franco , and Arizona cypress (Cupressus arizonica Greene). Additionally, we have in nursery beds small lots of known origins of the following: white fir (Abies concolor (Gord. & Glend.) Lindl.), 3 sources; blue spruce (Picea pungens Engelm.), 2 sources; pinyon pine (Pinus edulis Engelm.), 2 sources; and Southwestern limber pine (Pinus flexilis var. reflexa Engelm.), 1 source. Further comment will be made on the first four species named.

Jack pine -- One might reasonably inquire as to why jack pine has been selected for our most intensive experimentation. The reasons are several: First, there is an early and abundant cone production. We have control-pollinated trees four years old from seed; and, varying greatly with trees, many cones are produced after the fifth year. Second, the species makes rapid early growth, placing within the realm of possibility a Christmas tree rotation of 3 or 4 growing seasons, starting with 1-0 stock. Last, jack pine is characterized by a high variation in characteristics affecting Christmas tree grade. Trees have been selected because they possess in outstanding degree any or all of such traits as fast growth, green winter color, wide angle of branching, narrow angle of branching, symmetry of crown, compact crown, and open crown. Controlled pollinations are being effected to learn heritability patterns for such traits, and the first seeds of these crosses are ready for the nursery beds.

Some interspecific hybridizing has been undertaken with jack pine. Using several geographical origins of lodgepole pine (Pinus contorta Dougl.) pollen, some seed have been obtained. Efforts to cross jack pine with spruce pine (P. glabra Walt.) and sand pine (P. clausa (Chapm.) Vasey) have thus far failed, but we have not been satisfied with seed yields in general from control-pollinated cones. Studies are now being conducted to improve our control-pollination techniques.

Our plantings of jack pine include trees of more than twenty proveniences; but, because of drouth losses, only seven can be compared. Significant differences attributable to geographic origin have been found in both survival and rate of height growth. These plantations are presently 8 years old. Best growth has been obtained from seed of a Pennsylvania plantation rated as superior. Also, our plantings from this source contain a few trees of outstanding quality.

Interesting differences were obtained in comparing progenies obtained from two open-pollinated trees growing on the Chippewa National Forest in Minnesota. Although these mother trees grew within several miles of each other, approximately half of the seedlings from one were variously killed back or died outright early in the second growing season while those of the other tree were uninjured. This happened in each of the five replications that made up this test. Further study would be required for a clear explanation, but it did appear that seedlings of the injured source broke dormancy promptly during some unseasonably warm days early in March of that year (1955) while those from the other tree did not. Trees of the uninjured source have continued to make a better development.

Scotch pine -- This species is the only one currently recommended to Missouri Christmas tree growers. We have been slow to experiment with Scotch pine through individual tree selections and breeding studies, however, for the species is slower in producing seed than is jack pine. Moreover, although Scotch pine plantations are vigorous for a few years, mortality sets in beyond ages of 10 or 12 years. Another problem is severe sapsucker injury to tree trunks of small pole sizes and larger.

Work with Scotch pine has been primarily in testing commercial sources of stock. While striking differences have been obtained between seedling lots marketed as being certified from different geographical races, there has been a lack of consistency in the performance of such certified origins on a year-to-year basis. We have, for example, had both beautiful dark green to blue-green trees and winter-yellowing trees developed from separate lots of nursery stock, each labelled as Riga Scotch pine. Also, seedlings advertised as being from special, selected,. blue-green parentage have not produced the suggested colors. It would seem that this racial problem with Scotch pine can be best approached by having foresters collect for testing purposes seed throughout the natural range of the species. It is my understanding that some states have such projects under way.

Douglasfir -- Although it perhaps will never be advisable to plant this species extensively over Missouri, Douglasfir, started with 2-2 stock, has performed well on river hills soil of loessial origin. It seems likely that good results could be obtained with the species on other soils of good internal drainage. Based on a study of Douglasfir in its natural Rocky Mountain habitats, it would appear that the edaphic factor

may be more limiting in Missouri than moisture or temperature considerations, for example. Our Douglasfir plantings have invariably failed on heavy, plastic, poorly drained soils. On a well-aerated soil of the kind indicated, however, excellent trees can be produced over an 8 to 10-year rotation.

Racial tests of Douglasfir have been started. Seed from 23 geographical sources was collected and sown in two nurseries. These were mostly from Colorado, Arizona, and New Mexico but Texas, California, Oregon, Washington, Idaho, and Montana are also represented. The stock is now 2-0 in the nursery beds, too young to appraise in many respects. Also, damping-off losses at both nurseries reduced seedling numbers far below those quantities wanted for field testing. Nevertheless, striking differences have been revealed, with the results at the two nurseries being in agreement. After a spindly initial development, seedlings from the Pacific Coast seeds winter-killed in Missouri.

Best early results have been obtained from central and southern Rocky Mountain origins, but great variation is found between sources obtained within this more restricted zone. Seedlings representing some stands within this 3-state area of Colorado, Arizona, and New Mexico have almost failed while others have made a vigorous development, their heights after two growing seasons ranging up to 16 inches. This taller stock is of heavy caliper too.

None of the Douglasfir seed sources have produced seedlings of good winter color. It is too early to evaluate this factor. Some seedlings, although fast growing, are showing a winter injury at their tips. This is true of a Sierra Ancha source obtained near Young, Arizona, at an elevation of 7300 feet; but seedlings from a Cloudcroft, New Mexico origin at 9000 feet seem immune to such injury.

Arizona cypress -- Six collections of Arizona cypress seed were made, representing a range from the northernmost occurrence of the species in Oak Creek Canyon near Flagstaff, Arizona, southeastward to the Chiricahua Mountains. Most seedlings of all sources were winter killed in Missouri at -15 F. A few seedlings each of five sources have survived without apparent injury, however, and have continued to make a rapid growth. Sizes of the 2-0 seedlings range upward to 40 inches, with stem diameters as large as 1.1 inches. This strongly indicates a marked range of cold hardiness within a local population of this species. One cannot predict how the few surviving seedlings will continue to fare under Missouri conditions.

Other than these Christmas tree improvement efforts, a few seed-source plots of shortleaf pine (Pinus echinata Mill.) have been installed in cooperation with research personnel of the U. S. Forest Service. Some of these small plantings have been destroyed by deer.

Additionally, using stock obtained through vegetative propagation, some work is being done with a hybrid poplar (Populus alba L.x P. grandidentata Michx.) and a selected form of P. deltoides Bartr. It is too early to evaluate this limited work with shortleaf pine and the two poplars.

What direction would any expansion of tree improvement research in Missouri take? As already indicated, we would be interested in conducting racial tests of Scotch pine. Other species of primary interest are eastern cottonwood and black walnut. It is our opinion, however, that future work in individual superior tree selections, seed orchard development, and breeding should give top priority to shortleaf pine. It appears that this pine will continue to be our most planted species under a forestation program that seeks to rehabilitate the extensive tree cover of the Missouri Ozarks.