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HOW MUCH FOREST TREE IMPROVEMENT CAN BE EXPECTED FROM SILVICULTURAL AND FROM GENETICAL METHODS

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SILVICULTURE IN RELATION TO FOREST TREE IMPROVEMENT

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Silviculture, as the word implies consists of cultivating forests to meet a certain objective. This objective is usually the greatest possible quality and quantity production of wood grown under local economic limitations. Silviculture has a far greater influence upon quality than on quantity production, after full foliage cover has been obtained. To illustrate, it is definitely known that for a given species, age and site, production is not directly proportional to the growing stock. Also, it seems fairly well established for certain species, that the same amount of wood substance will be pro= duced on growing stocks ranging all the way from the maximum possible for the species, age, and site down to approximately one-half of this maximum.

Silviculture will therefore be primarily concerned with improvement of tree quality and in the maintenance and improvement of the site. The latter, a very important problem, will be left out of my discussion today.

Natural Stands - Extensive Forestry

On the relatively undisturbed forest soils, silviculture deals mostly with naturally established stands, Under economic conditions that permit the practice of only extensive silviculture, little more can be done than to protect the forest against fire and pests until the crop is harvested. It is difficult under such economic conditions to avoid harvesting the best species and individuals and leaving the less desirable. However, by timing the harvest cutting with seed production of the desirable species or leaving superior

individuals of the best species as seed trees it is often possible to improve the forest even under the limitations of extensive forestry. It is hoped, that certain statements regarding seed trees as can be found in a such used state bulletin will not appear in the future: "If they are crooked or forked, which lessens their merchantable value so much the better, as these defects do not lessen seed production." The author does not take into consideration that some crooks and forks may be genotypically determined and thus be perpetuated in the progeny.

Natural Stands - Intensive Forestry

Under natural forest conditions where cultural work is practicable and where small trees can be removed at a profit, it is possible to improve the forest, consider

ably. The natural reproduction, ranging from several thousand to several hundred thousand trees per acre, will be reduced during the rotation to about one hundred. With very short rotations, there may be several hundred trees per acre at harvest time. Under all conditions, the reduction of number of trees from the seedling; stage to maturity is drastic. If this process takes place without interference by man, the fittest individuals will survive. But the fittest in the sense of nature are only in part the most desirable from the point of view of man. Many perfectly straight, healthy, potentially valuable trees will be lost in the competition with more robust individuals, or many coarse or crooked trees, or trees with extensive heart-rot will remain in the final crop.

This picture is changed by thinnings as applied in silviculture. Foresters will, like nature, in general favor the leading trees but require that these trees be well formed, healthy and in positions to grow well. The "wolf" tree, the "bully" of the forest, is in the forest society - as in the human society - an undesirable member. He requires a lot of room, suppresses more desirable individuals, and produces a poor return considering the space he demands.

An important objective, especially during the early thinnings, is to eliminate "wolf" trees from the treated stands. Thinning should result in turning the site over to the best individuals - the best phenotypes - and give them optimum growing space. The reduction of stems and volume through thinnings is usually much more drastic than if the forest is left to nature. A middle aged stand, producing quality sawtimber will probably have been reduced from three to five hundred trees per acre by several thinnings. These trees should then, from outward appearance, be among the healthiest and best formed trees in the original population.

In many stands reproduction will already begin to tike place at this stage. In other cases reproduction may be delayed until additional thinnings have further reduced the number of stems and thus further selection occurs.

At rotation age the hundred or less trees remaining serve primarily as parents for the new crop and have, through repeated thinnings, been selected from the original several thousands. They should be the best phenotypes available and it may be expected they also will include a large percentage of the best genotypes in the original population. To determine this, further testing of the progeny under different environments will be necessary.

Some foresters choose the required number of crop trees at the time of the first thinning. These crop trees are then favored at all later thinnings. This method is of course preferable to the straight removal of undesirable trees without consideration of trees to be favored. I believe however the over-all favoring of the best available elements at each thinning - treatment of the stand as a unit - is the best method. It is very difficult to select final crop trees as young as twenty years. There are many factors influencing the stand during the following forty or eighty years that make early fixed crop tree selection impractical.

Interplanting in Natural Stands

So far, consideration has only been given to purely natural reproductions. However even here better species or progeny of plus or even elite trees may be introduced into the stand by interplanting at wide spacing. This is often difficult on account of competition with the existing vegetation but may succeed where large stock is used, combined with careful planting and some cultural work. Promising clones may be introduced in the wild stand through grafting or budding. On a limited scale this type of work is already carried out in practice in certain places abroad. When clones are introduced in this manner it seems desirable however, to introduce several different clones in the same stand in order to avoid too great uniformity.

Planted Stands - Tree Seed Requirements

On old forest soils little influenced by man, natural reproduction methods are almost the only methods used today. It is likely however, as we realize the economic possibilities that intensive forestry offer on the better and accessible sites, that artificial reproduction will be used here also on a larger scale. On abandoned agricultural fields, heavily burned areas, and other non-regenerative, unproductive areas, artificial reproduction must be used to establish forests. We have known for years that the seed should come from the best possible origin. Not only a provenance that will match the planting area ecologically, but also from parents that have the many qualities we want in the new crop. Much progress has been made. Unfortunately, we are still far from using in practice even the knowledge that we do possess.

We should appoint forest tree seed boards, state by state or region by region, to select stands of the more important species for seed collections. We will not, for some time, know whether the quality of such certified stands is due to heredity or environment, but it is likely that they will furnish superior plants. It will be the task of research organizations to test the progeny under different environments in order to determine genotypical qualities. It will take time to get reliable results, but it is probable that within five or ten years some results can be obtained.

In addition we need seed orchards to lower the costs of seed collection and tp produce the best seed possible. These orchards require large areas free of trees that might pollinate the orchard trees. The standard used in Europe is 500 meters. This means that a seed orchard requires at most 180 acres free of the species planted in the orchard. Sites for seed orchards must therefore be selected with great care and can place a considerable burden on management.

Vegetative Propogation

Vegetative propagation is difficult and requires special grafting or budding techniques. But the "progeny" may, at least during the early years of growth, behave in a peculiar manner. They retain the character of the place on the tree from which they are taken. In other words a scion from side branch continues in part to behave like a side branch while a topshoot continues to behave like a topshoot. It would be of interest to test whether the growth patterns characteristic for the age of the tree also are retained in the scion.

Tree Improvement in Nursery and Plantation

Considerable selection takes place in the processes of producing nursery stock. The lightest seeds are eliminated in the cleaning process. The weakest seedlings die from a variety of environmental causes in the seedbed. Considerable culling of poorly developed trees takes place before shinnying and further culling is often done by the planters.

The heaviest field mortality usually takes place in plantations during the first years. Most of this mortality is undoubtedly due to the method of planting but some of it may also be due to hereditary characteristics of the plants. The number of plants set out in a plantation is usually much lower than the number of plants in a natural reproduction. The opportunity for selection through thinning is therefore reduced. Even in this case, however, only one of a thousand seeds collected is estimated to reach the final harvest crop in an artificial forest plantation.

The Task Ahead

Wider application of sound silviculture leads to forest tree improvement. Foresters need greater knowledge about our trees. We need to clarify more clearly which characteristics are desirable and which are undesirable. We need to locate the superior genotypes. It is within this area of forest tree improvement that work - and a great deal of work - is needed. It is not "flashy" work and it will take time. But I believe nevertheless that it is the surest road forward.

Forestry is different from agriculture. We have long crop rotations to deal with. We cannot afford to find our trees developing weaknesses in growth rate or resistance to diseases or environment after thirty or forty years of splendid performance. We must have reasonable assurance in large scale forestry that the crop will maintain growth, health and form until the end product is reached.

Hybridization is of course more exciting and it may be easier to secure private funds for that type of work. But when a promising hybrid has been produced a very long time of actual testing awaits before it can be safely advanced for large scale use. In contrast, the plus-trees that we find in nature have demonstrated what they can do. All that remains is to determine if their performance is due to inherited characteristics or to environmental influence. This can be indicated in five to ten years. Testing of hybrids will take many times longer.

The progeny from seed orchards can also be used with reasonable reliability in practice. The plus-trees that have yielded the scions have demonstrated their characteristics. Crosses between such trees are likely to produce desirable variable progeny containing the characters of the parents. Again it must be determined if the selected, promising plus trees really are elite trees.

Selection of good stands and plus trees and testing of this material to find elite stands and elite trees should be foremost on a forest tree improvement program. Cytological work and hybridization should go hand in hand with selection and testing. But hybridization should be done with selected and tested plant material.