TRENDS IN FOREST MANAGEMENT AS INFLUENCED BY TREE IMPROVEMENT

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Abstract.--The most immediate effect of tree improvement has been the increased effort in several areas of forest management either to answer questions raised about the best way to take advantage of the improved stock or to develop methodology to accommodate the improved trees that are now being produced. A whole series of tests have been made because of the inclusion of operational tree improvement programs as a part of forest management. For example, some of the best work done on the effect of wood quality on the final product was started to answer questions about the value of changing wood qualities and, even greater, about the effect of shortened rotations yielding high proportions of wide-ringed juvenile wood. Extensive and expensive studies, even to mill-scale proportions, have been made to obtain the information needed.

The effects of including tree improvement in forest management extend through seed handling, nursery operations and silvicultural techniques. Much has been learned relative to obtaining the highest seed yields during extraction and the highest seed-to-plantable seedling ratio in nursery operations. Silvicultural methods related to initial stand density, thinning (including need for precommercial thinning) and especially rotation age are greatly affected by inclusion of faster-growing and better-quality trees. One of the greatest results from application of tree improvement is to enable profitable forestry on what are now marginal sites through production of strains of trees specially adapted to such areas; many companies are now reassessing their concept of what sites are operable and what are not. Development of special strains for marginal sites is making economically operable millions of acres not formerly available.

INTRODUCTION

Forest management practices have changed dramatically in the South during the past 30 years. To a considerable extent the change has been triggered by the inclusion of tree improvement as an integral and operational part of forest management. Direct and indirect pressures resulting from findings or questions raised by tree improvement have resulted in many tests and research activities in the area of forest management. I have said for many years that the indirect effect of tree improvement on forest management is so important that the greatest immediate gain from tree improvement has been the information and activities generated by the search for answers to the questions raised.

A good example of such indirect benefits relates to wood qualities and the properties required for different products, along with the effect of rotation ages on these properties. One of the criteria for a seed orchard in the N. C. State-Industry Tree Improvement Cooperative was to supply wood with specific gravity suitable for the particular product of each organization.

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We obtained a written statement from each member of the Cooperative, signed by a high-level company official, indicating its desires for wood qualities and placed it in our safe as a part of the permanent record of the Cooperative. As a result of this requirement, several organizations which did not know the gravity they desired started some excellent studies on the effects of wood of differing qualities and ages on the desired product; some studies were even made on a mill scale.

The influence of tree improvement has been marked on all phases of forest management. Although somewhat of an oversimplification, the major gains from tree improvement essentially are: (1) shortening the time it takes to produce a given volume of wood, and (2) increasing the quality and size of the stem on which the productive potential of an acre will be "packaged." The tree improver will not radically change the total amount of cellulose produced by a <u>mature</u> stand on a given acre, but he can strongly influence the form and quality of wood produced as well as accelerate the time to grow a given volume of wood using shorter rotations.

Stated alone, the objectives of a tree improvement program seem simple, but their fulfillment is difficult indeed and requires a "marriage" of the improved trees with the best forest management practices available. The need for the complementary genetic and forest management approaches was realized very early and resulted in studies that would otherwise not have been done. For example, no one will argue that good planting stock is not required to get the best return on the investment for intensive site preparation; similarly, the planting of improved trees without the best forest management is a waste of time and effort. Since one of the greatest gains from genetic manipulation of forest trees is the production of the desired tree in a shorter period of time, the need to adjust utilization methods and products for greater volumes of wide-ringed juvenile wood has received a great deal of attention.

STAND DENSITY AND THINNING

The most controversial subject in forest management today is what is the optimum stand density. What constitutes the ideal number of trees per acre is continuously being reviewed and revised. In fact, opinions on the ideal stand density range back and forth like a pendulum.

As faster-growing, better-formed trees become available through tree improvment programs, plantation spacing has been increased, resulting in fewer but larger high value stems per acre. The trend towards wider spacing of a final crop of better quality trees has become rather general on a world-wide basis, although a few organizations still champion very close initial spacing, even to the extent that precommercial thinning is required. Initial close spacing and precommercial thinning to improve stand quality is not necessary when really improved trees are available and wider spaced stands of improved trees can be established to grow to a commercial size before thinning. With initial wide spacing and improved stock, I have seen operations where trees suitable for use as solid products are obtained at the first (and only) thinning.

The attitude relative to plantation stocking throughout the world has historically been towards "too close" spacing, sometimes requiring precommercial thinning. The feeling that "if a few are good, more are better" has been all too widespread. The physiology of tree growth and needs for nutrients and moisture have been overlooked.

With the availability of improved planting stock, the argument that many trees are initially needed to allow sufficient trees of quality at time of harvest, is no longer valid. The genetically improved trees now starting to be harvested in the South are of such a quality as to have a major impact on forest management relative to what are proper stocking levels in plantations.

ROTATION AGE

One of the major objectives of tree improvement is to produce the desired yield and quality crop of trees within a shorter period of time than is possible using "run-of-the-mill" trees. This is being partially achieved at the cost of increasing the proportion of wide-ringed juvenile wood. If this kind of wood is to be efficiently used it will require some change in methods of manufacture and product development. We have been successful in breeding higher density juvenile wood with resultant greater strength but the wider rings still are a problem for which adjustments must be made.

Reducing rotation age is of major economic value. In a recent analysis by Lambeth,[2/] the increased profit from an equal percentage improvement in growth rate versus increased yield (carrying capacity) was estimated. Using a certain set of standarized assumptions, he found the following relative profits:

Treatment	Profit Percent
33-year rotation, no improvement	10%
33-year rotation, 10% gain in carrying capacity	21%
30-year rotation, 10% in growth rate only, same volume as 33-year-old unimproved stand	39%

Lambeth shows with this calculation that a 10% gain in growth rate with its shortened rotation age will give nearly twice as much profit as a 10% increase in carrying capacity with no reduction in time to harvest age.

Closely related to stand density is the suitability and need for thinning plantations. There has always been rather violent controversy about which thinning methods are best or whether thinning should even be done. The so-called "row thinning methods" have been under special criticism when they are applied to forest plantations established with unimproved stock. To many of us, row thinning of such stands is really not thinning at all; it is <u>only an early harvest</u> of the stand, resulting in no better trees in the remaining stand than before thinnings, but with the thinned stand now having one-half or two-thirds of the initial stocking. Despite any claims about the value of row thinning resulting from its ability to produce "less expensive wood," the practice has fallen into quite general disfavor except in those stands with ridiculously dense initial stocking because good trees are cut while poor trees are left. As better genetic stock becomes available, resulting in more uniform plantations, some of the adverse reaction to row thinning will have been removed and the main consideration will then be to maintain a suitable level of stocking.

[2/] mimeographed report

SEED EXTRACTION AND NURSERY OPERATIONS

Improved seed has high value. Depending on the company and product produced, the value of the extra wood produced from a pound of genetically improved seed at the time of harvest will be worth from $200 to nearly $2000 when discounted to the present. It is an economic necessity that all available seed be extracted and used. This need has resulted in greatly improved seed extraction, storage and testing methods.

Because of the value and scarcity of good seed, every effort must be made to get the highest ratio of seed to seedling and to get the best planting survival possible. As a partial result of this need, seed bed densities in operational nurseries using improved seed have been reduced drastically from as many as 50 or more seedlings/square foot of nursery bed to about 25 seedling/ square foot. Positive results in seed-to-seedling ratios and in survival and growth of plantations using improved seed have been dramatic because of the impact of tree improvement needs. Some organizations have even suggested growing their improved seed using special containerization techniques to get better seed-to-seedling ratios and field survival.

GROWING TREES FOR SPECIFIC SITES

A major pressure in southern forestry is the continuing withdrawal of the best forest lands for agricultural and other uses. Consequently, forestry must be increasingly practiced on marginal or submarginal sites. On such sites a profitable forestry enterprise is difficult to obtain if regular trees are used.

Some of the most successful tree breeding involves improved adaptability to marginal sites. As a result, many millions of acres are now being economically forested that were formerly unproductive or wasted. Special strains have been developed for excessively wet and dry sites, developing trees that grow in environments that are colder or more severe than in the species' native range has been especially successful. Large forestry operations in pines and hardwoods are now possible in submarginal environments using valuable species which once were not suited to the area; for example, whole new industries have resulted from growing loblolly pine in parts of Tennessee and West Virginia.

It is now generally recognized by all foresters that provenance (or geographic) seed source is of key importance for successful plantations. Most organizations are very particular not to violate the basic principles of seed movement. In some instances, outside sources have been used in widespread planting to replace indigenous sources because they have proven to grow better or be more resistant or more hardy than the indigenous source.

In a few regeneration programs, the environment of the progeny has been matched with that of the parent from which seed were obtained. One organization plants large total acreages by 50-acre blocks with seedling of different mother trees to better take advantage of the special adaptability and growth and form characteristics of particular genotypes. Such utilization of the genetic potential results in a radical alteration of the forest management techniques used in most operational regeneration programs.

SUMMARY

Forest management practices are currently undergoing dramatic changes. In many instances, these have resulted from, or been initiated by, pressures or needs to better use improved trees obtained from the tree improvement programs. Many sites formerly considered to be nonoperable or submarginal are now being routinely used for economic forest enterprises utilizing improved forest management methods and exploiting the especially developed strains of trees made possible through the use of genetics. Trees with higher value, better form and improved growth rate have resulted in better care from nursery to harvest, with resultant greater returns on the investment.

One major result of applying genetic principles in forestry is the production of trees of a desirable size in a shorter period of time. Although this is very favorable from a total production and return on investment standpoint, it results in a higher proportion of wide-ringed, juvenile wood which the industries must learn to utilize for their products.

As increasing amounts of better genetic stock become available, we can anticipate continued and increasing changes and continued specialization of forest management activities necessary to fully utilize the advantages of the quality trees that are available.