PRELIMINARY STEPS FOR TEE ESTABLISHMENT OF AN INDUSTRIAL TREE IMPROVEMENT PROGRAM

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The preceding papers have covered several aspects of tree improvement, and the panel considered the possibility of industrial application of tree improvement practices in the Northeast. In this paper I will make a few comments which will help justify immediate tree improvement efforts, and will list some preliminary steps which should be taken before a full-scale production tree improvement program is started.

As early as 1905 President Theodore Roosevelt remarked that, "The forest is for use and its users will decide its future." I'm sure that he was referring at that time to grazing and timber harvesting, but his words were very prophetic because the American public has begun to use the forests intensively and is even beginning to call the turn in management practices, not only on public, but private lands as well. We are seeing the amount of timber producing area eroded by the enroaching highway systems, pipeline construction, water impoundments, and recreation areas.

It is imperative then, for us, as wood users and/or timber producers, to maximize the product-yield on every remaining acre of prime timber land. In addition, we must learn to maximize yield on much land which is not prime for timber growth by sharpening and extending management procedures, and developing strains of the various species which are able to utilize these sites and benefit by intensive management techniques. Assuming that our economy will continue to rely on timber as an important resource, and that a growing population is going to occupy more forest land, the wood-using industries must initiate studies of intensive management techniques immediately.

One of the most important techniques for increasing production, used by growers of agricultural crops, is plant breeding. Agricultural species with considerable natural variation have been improved greatly utilizing the "selection" method; with the genetically wild state of forest stands, it would seem that great strides could be made through a simple selection program. Therefore, the potential of genetic improvement of our forests deserves careful examination and exploitation.

Industrial firms who are not now in a position to begin a production-oriented tree improvement program can do a great deal toward encouraging the preliminary investigations necessary to the future implementation of a full-scale program. Although any work done along this line will cost money, to use a well worn but appropriate cliche, the question is not can we afford to do it, but can we afford not to do it? Forest tree production is a long-term proposition, and breeding cycles cannot be shortened much, at present. Therefore, the time to begin is now.

What then can forest industry do to initiate steps toward establishing its practical tree improvement program. Preliminary procedures can be divided into three phases, all interconnected:

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1. Management decisions
    a. Land
    b. Product

2. Cooperation with outside research organizations, and

3. Industrial research and management efforts.

The first of the three phases must obviously be carried on by higher echelons of management. Their success in "crystal ball gazing" will ultimately determine the success of their entire tree improvement program. Management decisions can be subdivided into land and product policies. First, the land managers must review the company's land holdings and determine a future land-use-pattern recognizing the possibilities of loss to agencies such as housing development, water impoundments, and especially today, recreation activities. Much of the area which may be claimed for these purposes is prime growing land, and it would be foolish to spend great amounts of money breeding trees which can thrive mainly on these areas. Trees bred for highly fertile conditions probably would suffer when planted on less productive land.

Once the more permanent production areas are delineated, future management practices must be projected. Some of the questions which should be answered are:

1. What acreage and land pattern is available?

2. What kind of regeneration plan will be used?

3. What species will be emphasized?

4. How long is the projected rotation?

5. Will fertilization be used?

6. Will some method of controlling unwanted vegetation be used to eliminate competition or insure that all the benefit of fertilizers will accrue to the crop trees? If so, what will this method be?

A fundamental problem arises in connection with land management activities and a tree improvement program. This is concerned with the method of introducing genetically improved material. We need to know:

1. Can certain areas be clearcut and planted, as is done in the South?

2. Will superior seedlings have to be planted in small openings as selective logging takes place?

3. Will large openings be created and planted?

4. Will the areas be direct-seeded?

All of these factors influence the size of the orchards that will be needed to produce the requisite amount of seed; and the type of genetic manipulation that will eventually be used in the breeding program.

Now, the second part of phase one--the upper echelons of "product" management must also turn to the crystal ball. I am told that management-projections are now being made for a five-year period. But, when one is dealing with a long-term project such as a tree improvement program, five-year projections are only a beginning. Management must endeavor to determine what raw material will be needed in 25, 50, or 75 years and relay to the geneticist information concerning the type and quality of fiber desired.

Naturally, the first requirement is greater fiber volume. But the geneticist must ask again, "Volume of what?" Are we interested in producing a veneer log on a short rotation? Will selection, for example, be restricted to the characteristic of rapid diameter growth with no regard to height? Certain agencies are making superior selections on this basis using the argument that for high quality hardwoods the dollar value is in the butt log. For this type of volume increase, rapid natural pruning of the lower bole is an additional desirable characteristic and elimination of epicormic branching is a prime concern.

In contrast to this type of selection, we may be interested in high volume production where both height and diameter growth are considered. Additional benefits might be accrued by selecting breeding stock with low specific gravity and thin cell walls which will produce fiber for making fine paper with high printability. Selection programs based on vastly different characteristics must be developed for each of these examples.

Once these decisions have been made, the geneticist will determine, first, which characteristics can best be altered genetically; second, which will respond to environmental manipulation; and third, which are incompatible and must be ignored or relegated to a minor position in the breeding program.

Together then, the land manager, "product" manager, and geneticist determine the goals of the future breeding program.

The second phase is concerned with industry in cooperation with outside research organizations such as public agencies and universities. Close coordination among these three should be very rewarding, in that the goals set by industry can be furthered in existing research stations where there is fundamental expertise in many fields. For example, in the university, specialists in fields such as wood technology, silviculture, ecology, biochemistry, entomology, pathology, statistics, and genetics are available for immediate and continuing consultation. Here also are located the sophisticated computer centers for processing masses of data. Fundamental problems can be attacked through a team approach and answers obtained in a minimum amount of time.

Recent location of federally supported experiment station units such as those of the Forest Service near or on university campuses has encouraged cooperation and coordination, making both the university and Forest Service research more efficient.

Researchers in these organizations need to know the questions being asked by forest managers. Only Industry must make its needs clear to public research agencies. Companies, individually and collectively, need to inform deans and experiment station directors of their informational requirements and, by doing so, encourage the writing and the approval of suitable research proposals. Although this is not a pitch for monetary grants, obviously, financial support for experiment stations is needed and welcome. At least three very successful industry-supported programs come to mind in the genetics field, one of which is well known to you all. This is the North Carolina State Industry Program, headed by Dr. Bruce Zobel. Here Industry has been a moving power both with requests for information and in financially supporting the proposed projects. Other examples, perhaps less well known but productive, are those of the University of Florida and Texas A & M University. The Industrial Council on Forest Disease Control is another example of an industry group making its needs known and collectively financing research.

There are other means of industrial cooperation which do not require direct monetary grants, but aid immeasurably in research efforts. An example of this, involving an industry not concerned with forest products, is the agreement between the Kaiser Aluminum Company, the West Virginia Department of Natural Resources, and West Virginia University. The company has made a yellow poplar plantation available for research in seed production, orchard management, and the effect of fertilizer application.

This type of agreement is extremely valuable since the location of suitable experimental areas is often a serious problem because state ownership is limited, and small private ownership is of transitory nature. Only land owned more or less in perpetuity can be safely used for a long-term experiment and therefore large tracts of permanently-owned industrial land are highly suitable. If industry would make such land available to geneticists, tree improvement programs would be expedited. Cooperation also could be extended to include assistance in planting, measuring, managing, and protecting research areas, all at minimal expense. The donating company would benefit because tests would be installed on land comparable to that which will be used for future commercial planting, and material grown could revert to the industry at the termination of the experiment.

Another type of company assistance is the collection and transmittal of experimental material to the cooperating agencies. Any assistance offered by industry will aid in the search for answers to questions of a fundamental nature. Such essential information would then be available to the companies when they were ready to design and implement a full-scale program.

The third phase of preliminary investigations can be carried on by industrial research foresters in cooperation with their management foresters. Some of these activities concern practical aspects of management and differ among companies. For example, practical methods of regeneration, and silvicultural treatments can be developed utilizing nursery run stock before genetically improved stock is available

Of prime importance, and a step which should be taken immediately, is the selection and preservation of superior stands and superior individual trees. An active selection program will contribute tremendously to the success of the tree improvement effort. Every stand that is harvested before being thoroughly searched for superior trees adds to the possible loss of irreplaceable genetic material. Too often even selectively-cut stands are high-graded and the most vigorous germ plasm lost. This is comparable to a farmer butchering and selling his best breeding stock, leaving only the culls for reproduction.

Superior selections should be described and their location mapped in detail so that they can be relocated when needed. Very little special training is necessary for the location of superior trees and this could be supplied by cooperating agencies in the form of a series of seminars. Then field foresters could conduct the search before harvestable stands were marked for cutting.

A corollary and also extremely important preliminary step is the establishment of a "clone bank" or tree collection, where five to ten grafted or rooted individuals (ramets) from each superior tree selection are planted for future use. This insures that individuals with superior genetic qualities are preserved in a central area for future vegetative propagation or controlled hybridization. The clone bank, if properly designed, can be a source of information leading to the estimation of heritabilities. Such information tells the geneticist how strongly characteristics are inherited and helps determine how much improvement can be achieved. If the grafted trees are properly spaced, the clone bank can be used to study seed production, seed stimulation, and general orchard management. The clone bank can also be the beginning point for controlled-crossing programs leading to seedling seed orchards, or progeny tests.

Concomitant with the development of a clone bank must be the development of a system of record keeping. This is an essential procedure for any genetics program and it establishes original records for future tree improvement efforts.

Since little is known about the controlled pollination of most forest tree species, another contribution by the company research forester could be the development of techniques for controlled pollination. Practical methods for making large numbers of artificial crosses could also be developed. Seed collection techniques must be developed for many species and this could be done in company clone banks.

Of special importance to a company are wood characteristics, which could be investigated by either company or public research organizations. However, information collected by a public agency is public information whether the necessary research is privately funded or not. Therefore, if a manufacturing advantage is to be derived, through special fiber characteristics, the company research organization itself must do the work.

Obviously, there are many research projects which can be carried on in a company research station which would contribute to the successful implementation of a tree improvement program; but, the initial selections and clone bank establishment are of prime importance.

I have presented a few ideas concerning preliminary steps a company can take before establishing a full-scale production tree improvement program. These have ranged from simply planning, to considerable implementation. To provide more and better wood products, we need more and better trees. To produce better trees, we need better genetic material. To have better genetic material, we must recognize the importance of making superior tree selections now before the best individuals are gone.

DISCUSSION

CECH - We keep talking about fertilization and breeding trees that will respond to fertilization, and yet one of the trends today is to belabor regular crop fertilization because of the amount of contamination which the water run-off carries into our lakes and streams. Do you think, Dr. Schreiner, that we might be heading for difficulties if the Government clamps down on the use of inorganic ,fertilizers?

SCHREINER - Perhaps I can answer that by reference to a recent inquiry from Michigan on the possibilities for using hybrid poplars on a proposed project for use of waste water to irrigate 10,000 acres of marginal land. This is where we could most effectively apply mini-rotation forestry. I understand that results at Penn State indicate that none of the organic matter gets more than a foot or two below the surface; apparently, the trees and crops utilize it.

CECH - You've been talking about organic fertilizers rather than inorganic.

SCHREINER - I don't know how far inorganic fertilizers would go. I don't think we will use them as heavily as they do in agriculture; we may not have to. With minimum effective application, most of the fertilizers should be utilized by the trees and undergrowth.

WEST - Concerning the decrease in specific gravity of fertilized wood over the unfertilized--how does this relate to the proportion of springwood and summerwood?

GLADSTONE - We haven't measured that yet, to tell you the truth. I suspect we're going to see a decrease in percent summerwood. Greater proportion of springwood results in the decrease in specific gravity. Now, how does that jibe with what we saw in the pine where latewood gave a higher yield? Some work we did in red pine on some of Leaf's fertilized material from Pack Forest indicates that, even though we see a decrease in the amount of latewood in those samples, a thickening of the walls in the earlywood that we do have is probably responsible for the increase in the pulp yield. It was kind of unexpected as was this yield difference we are finding in the Douglas-fir. I'm not ready to say that that's the reason yet, but I suspect it is. Anything we do to increase wall thickness generally is favorable from a chemical aspect.

WEETMAN - Don't your costs--total pulp operating cost of $45 per ton--don't the costs increase with an increase in wood yield? You're taking one percent increase of that figure to justify the figure of S22,000. Surely these costs also rise if you are getting more yield from your wood. For example, it will require more chemicals.

GLAD_STONE - No, it will not. If you get more pulp out of a given weight of wood, then your chemical cost or any of your conversion costs are going to decrease, are they not?

WEETMAN - I don't know. Does it take more chemicals to produce it?

GLADSTONE - No, that's the other point I was making. The only thing in the Douglas-fir conversion that was altered was time. Chemicals per unit weight of wood in both cases were the same but a higher yield by a couple of percent was realized in the case of wood from fertilized plots. That's one of the points of the whole thing. If you're looking at specific gravity or yields per unit volume; then,indeed, if you have a heavier piece of wood, if you have a cubic foot of high specific gravity wood, you add chemicals according to the weight of wood substance there. Your costs would go up proportionally. Not so with yield per unit weight of wood. This is one of the points I should have made a little clearer.

CARLAW_ - Mr. Cech, at the risk of revealing my ignorance, are we not saying something that was in conflict with what was said this morning when you say we are risking losing superior clones by the cutting of trees, when this morning it was indicated that, by reason of natural reproduction, we were protecting this clonal source?

CECH - We had some discussion of this at lunch, and I think that this depends on the species you're speaking of and methods of cutting. It also depends on whether you feel that the particular genetic combination of an individual superior tree is being diluted by poor pollen and perhaps will never occur again. At least, this is the way I look at it. Ernie, do you want to comment on that?

SCHREINER - This is something we could discuss for the rest of the day and come to no agreement. When I think of the millions of trees available for selection in New England, I'm not inclined to worry about lost genotypes.

CECH - I think a lot of it depends on where you work and the type of previous management, type of regeneration, and so on.