Global Tree Improvement Compared to That in the Southern United States

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ABSTRACT

Progress in tree improvement is very rapid throughout the world both in the well established and newly developing programs. Progress is particularly rapid in tropical forestry because of the nature of the species and very short rotations. The only major criticism of the global tree improvement effort is the tendency to "follow-the-leader" whether or not the activity is applicable to the organization involved.

Despite the currently good financial situation in the forest industry, plentiful funds are not available to tree improvement, especially in the Southern U.S., where forestry research is still not generally recognized as being essential. In the tropics, intensive forestry is largely dependent upon exotics where provenance differences and land race development are keys to success; the approach is somewhat different when indigenous species are planted.

Several current areas of emphasis in tree improvement are mentioned. These are vegetative propagation, quantitative genetics and biotechnology, including genetic engineering. Some of the more advanced forestry organizations of the world are criticized for developing, but not thoroughly using, tree improvement principles. It is especially bad where inadequate silvicultural practices do not allow full development of genetic potentials. A case in point is in the Southern U.S. where insufficient investment in good forestry is enabling the newer forest areas in the tropics to become rapidly competitive in wood products. The Southern hemisphere is becoming a major competitor to the Southern U.S. and unless the latter better uses research knowledge, it will suffer. Additionally, new technologies have enabled the production of quality products out of marginal quality wood, thus enabling the tropics and sub-tropics to be even more competitive in many forest product lines. Use of good tree improvement principles will help keep the Southern U.S. competitive.

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INTRODUCTION

I have been greatly impressed by the coverage and the quality of the papers presented at this conference and those I have read from recent conferences. It is good to see this progress which is needed if the Southern United States is to compete with forestry on a world basis. Some tree improvement programs have been in operation for many years including those in Japan, Europe, Australia, South Africa and New Zealand. In fact, considerable work in the South was initially influenced by earlier work done in those countries. Currently, many new programs are developing very rapidly especially in the tropical countries, because of short rotations, early flowering, fast growth and the use of rooted cuttings. Even though much of the work in the tropics was patterned after the older programs, including those in the Southern United States, the tropical programs are developing so rapidly that they will soon pass the older ones unless a major effort is made in the rest of the world to keep ahead.

Two themes will be covered in this paper. The first relates to doing the research and the second is to apply (use) the research in operational forestry. The research reported at this conference is generally well done and has great potential for improving the quality and quantity of forests in the Southern United States, and I am quite complimentary about it. But I am less impressed by the use of the knowledge generated, especially in some silvicultural applications, a deficiency that, unless corrected, will cause the South to lose out to tropical areas.

One criticism, applicable both to the Southern United States and to other parts of the world, is the tendency to "follow-the-leader" and invest in unproven "fads" related to tree improvement. This is often to the extent of overlooking the developmental work needed before more advanced research can be put in practice or before an organization has the ability to do good research with advanced technologies. One finds less of this fascination with current "high-tech fads" in long-term programs such as in most cooperatives, but in any number of instances, they siphon off more than their share of available funds which reduces the amount of support for the more mundane but required studies necessary for tree improvement to be a successful operation.

AN APPRECIATION OF THE VALUE OF FOREST RESEARCH

Currently the forest industries are as well-off financially as they have ever been. Yet, this frequently does not mean an increase in research in forestry, especially in the Southern United States. Forestry in the Southern United States has the dubious honor of having the lowest outlay for research of any major industry with the possible exception of steel, when it should, in fact, spend the most because so little is known and because of the huge gains possible by combining tree improvement, silviculture and utilization technology.

The fact is that the value of forest research is not generally recognized either by foresters or administrators, especially the financial types who think only about term complications engendered by buyouts and mergers have often resulted in withholding of funds for forest research.

How often I have been visiting with a district forester or a general manager when a research report is placed on his desk. Much too frequently, it is glanced at and placed in the wastebasket, often with the comment "I wish they would quit sending me this stuff; it can't be used" (Not the actual quote). The fault is not all with the operational forester. A lot of researchers either don't know or care about the potential utility of their results and present them in a maze of technical language and statistical "gobbledegook" that reduce readability, understanding and acceptance.

On a world basis, there is variation in the acceptance of the need and support for tree improvement activities. Research activities in countries like Australia, New Zealand, South Africa, Korea and in Western Europe are generally well supported. In the Americas the recognition of the importance of tree improvement varies greatly by organization and company, but overall, research is not as well supported as in the countries listed. Frequently, the first two things mentioned when funds for research are sought are "How much does it cost?" and "Give me proof of the economic returns to be obtained". Not much is taken on faith or done with a missionary zeal as was possible in the late 1940's and 1950's when applied tree improvement became seriously supported in the Southern U.S. In the developing countries, and most of the tropical countries there is interest but lack of facilities, trained people or financial support. Much of the research applied in these countries is an adaptation of research done elsewhere, but there are some exceptions (such as in the use of vegetative propagation), where the tropics are leading the world.

When comparing tree improvement of the temperate and tropical parts of the world, the differences in their problems and thus in their approach, must be recognized. Tropical areas have forestry based primarily on exotics so the first job is to determine the best species and provenances to use. Then comes the selection and development of the best land race after which the more conventional breeding can be applied. These initial barriers are great and discouraging to one who wishes to develop his research capabilities quickly. Rapid methods of selecting the best land race do not exist. Some of the most dramatic failures in all forestry have resulted from using short-cuts to assess the best exotics to use. Thus, despite fast growth, short rotations and early flowering, the tree improvement specialist in the tropics does not have the simple nor quick job that many people think.

WHAT IS NEW IN TREE IMPROVEMENT?

It was suggested that I include a section in this paper on new activities in tree improvement. To do this satisfactorily would require a small book. Therefore, I will only mention three of the mere important activities with a few words about each. It certainly is necessary to keep up with and to invest in these "new" aspects of tree improvement, but not

to the exclusion of the older and more conventional activities, if tree improvement is to make its full contribution to forestry. The current trend to fund basic or fundamental research and to withhold support from conventional applied research is self defeating. It is necessary that both be done and supportive studies that are necessary must be teamed with the applied studies if the job is to get done.

One activity that is expanding rapidly and using new methodologies is vegetative propagation. Great efforts are being made to use vegetative propagation in operational reforestation, and with considerable success, especially in the tropical and sub-tropical countries. The benefits sought are greater uniformity within the forest and its products and greater utilization of the non-additive genetic variances. Although vegetative propagation is being researched by tree improvers throughout the world, the operational aspects of using rooted cuttings have generally proceeded much more rapidly in the tropical and sub-tropical parts of the world. This is in part due to the characteristics of the species used as well as to some good research and leadership. With many species, particularly the conifers, juvenility, which is necessary for good rooting, good growth and orthotropic form, is lacking. Much good work is being done to develop methods to induce juvenility in trees that have already proven their genetic superiority.

Another activity which has gone on for some time but is now becoming more helpful to the plant breeder, is in the area of quantitative genetics. Much of what has been done by the plant breeder can now be explained and breedomg methods suggested that the tree improver can follow to more efficiently make genetic gains in tree breeding. Especially valuable are crossing designsto reduce relatedness, or to use relatedness, in advanced generation or specialty breeding. Most of the intensive and sophisticated work on quantitative genetics is done where tree improvement has been emphasized for a long time. However, the general concepts are being used effectively in the more recently developed programs.

The third area, "red-hot" now and much emphasized, is what might be termed genetic engineering, including gene transfer and other sophisticated physiological methodologies. There are dangers in overemphasis of these technologies but it is important that they be pursued even though the "when" of operational payoff is not known. After they become successful a whole new horizon will be available for progress in tree improvement. Work of this nature is generally concentrated in the more advanced programs but some of the newer programs are also active unfortunately not always with the necessary quota of highly trained personnel, specialized facilities or sufficient financial support.

BECOMING TOO SOPHISTICATED TOO SOON

There is a tendency throughout the world to follow the new and exciting fads and to skip over the more mundane, and often more routine work needed for successful tree improvement operations. Many researchers, are frequently their bosses, are anxious to be leaders in their field; they try to do this by employing the most daring and sophisticated technologies, many in the high tech area which are not as yet proven operationally. New concepts come along and many people jump on the

"bandwagon" without too much thought as to their proof of success or potential usefulness. For example, what value is a prime method of vegetative propagation, or tissue culture unless one has the genetically improved material with a broad genetic base on which to apply the method or if the species or its wood are not deserved . There is a gap developing - it was evident in this Conference - where sophistication has sometimes exceeded the potential for application. An example is tissue culture - it can't be applied until foresters have learned how to effectively bring the plantlets from the laboratory phase to a plantable stage at a reasonable cost. It reminds me of the early days of rooted cuttings; when I visited many of the earliest programs reporting excellent rooting success I found to my surprise that many rooting studies had been carried only to the callous stage of the cutting and then terminated because the researcher assumed a calloused cutting would automatically root. The same is true with tissue culture - a plantlet in a test tube, (or a top without roots) will not automatically make a plantable tree. Good roots must be formed and the plant conditioned so it is physiologically suitable to grow under forest conditions. Many studies enthusiastically report tissue culture as being successful without the plantlets having been tested under field conditions.

The tendency to become too sophisticated too soon is particularly evident in the new programs, especially those in the developing countries. They often are trying to run before they have learned to walk.

THE APPLICATION OF RESEARCH RESULTS

One criticism of the countries and regions most advanced in tree improvement development is the general slowness of applying results. Often findings ARE NOT USED OPERATIONALLY on a scale needed to stay ahead of the rest of the world. This comment is usually made about forestry in general but it also applies to forest tree improvement. Too often, the genetic research has been done and the improved material may be available, but it cannot express it's full worth in increased yields, quality and adaptability because of lack of intensive silvicultural application. This lack is because of restricted application of silviculture and not the fault of the tree improver but it certainly reduces the value of the possible genetic gains. Why is it happening that the organizations supporting the research in the United States are not using known successful silvicultural methods to the fullest extent in their operational programs? Regardless of how good the genetic material produced is or the gains could be, they will not be obtained without optimal silviculture. Economic savings are often given by administrative personnel as the reason. "We can't afford that intensive type of silviculture" is a standard comment. A common belief is that labor is too expensive and land is more costly or unavailable in the United States in comparison with other countries. This is, of course, partially true but other forest management expenses can be great in the competitive regions. Although, intensive silviculture is not used generally throughout the world, it is quite commonly found in South America, which is becoming a primary competitor to the Southern United States. The basic problem is that many of the administrators in forestry

in the Southern United States feel they are the "woodbasket of the world" and thus are outcompeting others. They have not made sound assessments of the economic value of the improved tree improvement and silvicultural methods and the need to use them operationally. The fact is that the improved methods are needed if forestry in the Southern United States is to stay competitive.

I'm always challenged with "give me a good example". I could give many examples but one of the best has to do with competition control. There are numerous studies showing added growth (up to doubling) from good competition control within plantations. Yet, after the fairly good site preparation practiced in the Southern United States, the follow-up competition control is frequently poor despite its proven advantages. Nearly all foresters in the Southern Hemisphere know it is essential to use intensive competition control - those that don't simply lose out. Why is it that this one practice well proven to be highly beneficial, is not more widely used in the Southern United States? How many hundreds of times have I heard foresters say "Don't worry about that pine plantation, the trees have their leaders above the brush - they will make it". Certainly they will make it but at what sacrifice? Frequently growth is 1/3 to 1/2 (or even less) of what a free-to-grow plantation will produce. Under these conditions, much of the value from genetic improvement is lost. The only way to obtain maximum genetic gain is to control as many factors that limit growth as possible. There must be a marriage between good genetics and good silviculture if either is to produce anywhere near its potential.

IS THE SOUTHERN HEMISPHERE COMPETITIVE IN FORESTRY WITH THE SOUTHERN UNITED STATES?

The answer is definitely yes! This is in spite of many major problems in forestry in the Southern Hemisphere, both biological and social. One hears and reads about the wonders of forestry in the tropics and many people assume that all that is required is to plant, wait a few years and then harvest. This is generally not true and good forestry in the tropics requires more skills and more intensive management than in the temperate regions of the world. It also requires the development of more specialized genetic stock and land races to withstand the extremes in environments found there. Tolerance to adverse sites and pests must be developed within the exotic species commonly used in tropical forestry. Competition with planted trees is more severe and must be controlled, site preparation is sometimes quite difficult and must be very intensive and provenance and species differences are exacting. Soils are generally poor with often severe nutrient deficiencies so fertilization is essential. But despite these problems, when good forest management is applied and the proper species used, the environmental conditions are such that very fast growth results. It is not unusual in the tropics to harvest Gmelina for pulpwood in four to six years and Eucalyptus are commonly harvested at five to seven years. Pine in the tropics is grown twelve to fifteen years for small sawtimber or for pulpwood and often is thinned at eight years. Thus the initial costs and the intensive management investment in the tropics need not be carried on for long periods. The planted trees capture the site quickly, usually one year or less for Gmelina, one to two years for the eucalypts and two to three years for the pines, because of the rapid

growth. Thus, although initial competition control must be intensive, it does not have to be carried on for a long time period. Selection is sometimes made for dense crowned trees that rapidly shade out the competition.

Another advantage of the tropical and sub-tropical areas is that the genetic response to selection and provenance differences are much more dramatic than at the higher latitudes. Flowering is early and rotations are short so that selection and generation turnover in a genetics program are rapid. The species worked with - the exotic pines, eucalypts, Gmelina and others, have great variability so gains from intensive selection and breeding are large. A great advantage enabling full genetic gains is that most species can be reproduced vegetatively so that non-additive characteristics can be more easily used. Especially important, product uniformity can be great. One cannot overestimate the importance of uniformity. One of the major reasons why eucalypt pulp has become so competitive in the Southern United States, Europe, Asia and even in Canada is the uniformity and reproducibility of the pulp produced. As an example, at Aracruz in Brazil we are using in our vegetative propagation program only those trees with a wood specific gravity range between 0.46 - 0.52 and with high cellulose yields. As a result, the company gets 25% more usuable fiber per unit volume of wood than is obtained from unimproved wood. It is very uniform also.

Until the industry in the Southern United States obtains similar product uniformity, it will be at a disadvantage. One common problem cited in the short rotation tropical exotics is the large percentage of juvenile wood. This is of little importance in the eucalypts and Gmelina, where juvenile wood is not especially poor. It was a serious problem in the pines and at one time it was predicted that we would "drown" in excess juvenile wood. So it seemed until the technologies of TMP, CTMP, oriented strandboard and others have not only made it usuable but desirable for some products. Thus, improved technologies along with good genetic improvements have teamed up to produce products with very acceptable qualities which make tropical forest products competitive with those from the Southern United States. It is urgent to apply everything known in tree improvement if forestry in the Southern U.S. is to stay competitive.