IMPACTS OF TREE IMPROVEMENT ON NURSERY MANAGEMENT:

THE NEXT DECADE

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ABSTRACT

Tree improvement is established as an important silvicultural practice in the southeastern United States. Forty organizations (12 public and 28 private) are actively involved in breeding programs. These organizations collectively manage about 9,500 acres of seed orchards producing enough genetically-improved seed to grow approximately 1.3 billion seedlings and reforest 1.8 million acres annually. This is about 90% of all reforestation in the south.

Over the next decade, tree improvement will remain an integral part of forest management, but there will likely be changes impacting both forest and nursery management. First, the dynamic nature and consolidation of land ownership patterns may mean that fewer organizations are involved in tree improvement. Second, seed movement and the concept of an "appropriate" seed source will become an even more important issue. Third, a wide array of genetically-improved "varieties" (first-generation vs second-generation, disease resistant vs growth-improved, and different seed sources with all levels genetic improvement) will become available. Fourth, gene conservation and biodiversity will continue to be important issues. Finally, vegetative propagation through rooted cuttings may well become "pseudo-operational". Potential impacts of these factors on both tree improvement and nursery management are discussed.

INTRODUCTION

Tree improvement began in earnest in the southeastern United States in the mid-1950s. The early years were characterized by efforts to understand our genetic resources;

for example to determine if geographical differences among seed sources were important and to quantify whether economically important traits were under strong enough genetic control to allow successful breeding.

Much early research effort was also devoted to developing the techniques needed to implement a tree improvement program; for example, control-pollination, pollen and seed handling, grafting and seed orchard management. We can take these skills for granted now because of the efforts of our predecessors. Early tree breeders also had to be good sales people to convince forest managers of the potential value of tree improvement. Luckily, there were several foresighted forest managers that saw the value and committed resources to an, as yet, unproven technology.

Today, tree improvement is an integral part of forest management and all organizations of even moderate size have an active tree improvement program. Just as nursery research supports nursery production, so too there is research conducted in support of tree improvement programs; however, tree improvement is a proven technology that is completely operational. The objectives of this paper are to: 1) highlight the magnitude of current tree improvement efforts in the southeastern United States and 2) to describe some changes and trends that may occur over the next decade and their potential impacts on tree improvement and nursery management.

Status Of Tree Improvement In The Southeastern United States

Most tree improvement efforts in the southeastern United States are coordinated by three tree improvement cooperatives and the United States Forest Service. The largest tree improvement cooperative is the North Carolina State University - Industry Tree Improvement Cooperative with 24 cooperating organizations (Table 1). The Western Gulf Forest Tree Improvement Cooperative, housed at Texas A&M University in College Station, consists of 16 members, while the Cooperative Forest Genetics Research Program at the University of Florida has 12 members. These three cooperatives focus efforts on the commercially important pine species of the region: loblolly pine, slash pine, longleaf pine and others in decreasing order of emphasis.

In total 39 different organizations are involved in these 3 cooperatives: 28 private organizations and the 11 state forest agencies. Members within a cooperative cooperate on all breeding and testing efforts (to substantially reduce workloads) and freely exchange

Table 1. Current organizations actively involved in tree improvement in the southeastern United States, acres of seed orchard, and annual average production of improved seedlings and reforested plantations.

	Organizations	Seed Orchards	Improved Seedlings[a]	Plantations[a]
	(#)	(Acres)	(Millions)	(Acres)
NCSU[b]	24	4,000	630	900,000
WGFTIP[c]	16	2,000	350	500,000
CFGRP[d]	12	2,200	300	400,000
USFS[e]	1	1,400	50	60,000
TOTALS	40[f]	9,600	1,330	1,860,000[g]

[a] Annual average production figures based on average production of improved seed.

[b] North Carolina State University-Industry Tree Improvement Cooperative

[c] Western Gulf Forest Tree Improvement Cooperative

[d] Cooperative Forest Genetics Research Program

[e] Region 8 of the U.S. Forest Service

[f] 12 public and 28 private organizations

[g] Approximately 90% of southern reforestation

genetic material. Production of improved seed via seed orchards is conducted separately by each member. Cooperative members pay dues to the university-housed cooperative staff who, 1) develop breeding and testing strategies, 2) develop protocols for consistent cooperative-wide establishment and measurement procedures, 3) provide technical assistance

to members, 4) conduct supportive research and 5) manage and analyze data. Members physically conduct the breeding and testing efforts on their timberlands, while overall goals and direction are set jointly by members and cooperative staff.

Region 8 of the United States Forest Service conducts its tree improvement program separately from the three cooperatives. The Region 8 program has a broader focus on many more species than the cooperatives. Most emphasis has traditionally been on shortleaf pine, but many species have received emphasis. New species are being included in the program including more hardwood species and even non-commercial species (such as breeding dogwood for resistance to Anthracnose). The broad focus of the program emphasizes gene conservation for many of these species.

When viewed as a region-wide effort, there are approximately 10,000 acres of seed orchards producing enough seed annually to grow 1.3 billion genetically-improved seedlings enough to reforest 1.8 million acres (Table 1). This represents the vast majority of southwide regeneration. All private industries plant nearly 100% genetically-improved pine seedlings, and non-industrial private landowners purchase improved seedlings from cooperative-member nurseries, mainly from state-owned nurseries.

Thus, tree improvement is an operational reality in the southeastern United States. The magnitude of the region-wide effort is larger, by far, than anywhere else in the world, and the benefits are well documented. Over the next decade or so, several things may happen to influence region-wide forest tree improvement -- and hence nursery production and management. Some potential impacts of these changes are discussed in the next section.

THE NEXT DECADE

CHANGING LAND OWNERSHIP PATTERNS

In the past several years we have seen many mergers and consolidations in the private sector; this trend will likely continue. The business climate and management styles of publicly-traded companies tends to promote these types of business ventures. In the past 5 years, the number of private companies involved in tree improvement through the three tree improvement cooperatives has dropped from 33 to 28. If this trend continues, fewer and fewer organizations will have to bear the costs of the tree improvement programs and

other research efforts. Most likely, tree improvement programs will either need to become more efficient or be reduced in scope.

Another manifestation of these mergers and acquisitions is the disruption of productivity and instability felt by employees. In the past five years, one set of timberlands has been owned by four different companies. It can be quite difficult to conduct efficient tree improvement and research in this unstable climate.

Seed Movement And Seed Sources Issues

Geographic origin of the seed is an important consideration for many species in the southeastern United States. For example, if loblolly pine seedlings grown from seed collected in Maryland are planted next to seedlings grown from seed collected in Georgia, the Maryland seedlings will grow more slowly. Of course, the geographic gradients in loblolly pine are much more complex than this simple example. These gradients mean that choice of geographic origin is a critical decision in any reforestation project involving loblolly pine.

Much empirical evidence as well as theoretical considerations indicate that use of local seed sources for loblolly pine usually results in poorer yields than informed use of an non-local source. That is, a knowledgeable landowner can nearly always select a non-local source that will grow faster and/or be more disease resistant than just using seed from the local area. However, this requires that the forest manager be knowledgeable about the geographic patterns of variation. Also, there is risk of lower yields from mal-adaptedness if an improper seed source is used.

Over the next decade, choice of seed source will continue to be an important issue in nursery production. Industrial nurseries will likely be planting a wide variety of seedlots for use on company lands. For example, East Texas loblolly pine is already used extensively in the lower coastal plain because of its superior resistance to fusiform rust. Also, seed from North Carolina is being planted on moist sites in Arkansas because of its superior growth. The rationale for these seed movements is based on considerable experimental evidence, and they involve minimal risk for the promise of substantial gain.

The situation for non-industrial private landowners is quite different. Most are not knowledgeable about geographic seed source issues and rely on an expert (i.e., seedling grower, county forester or extension specialist) to guide the choice of seed source. This puts the burden on the expert to be well-informed and to work with the client to appropriately match seed source to planting site. Arkansas has already developed regulations that allow

However, seed certification is very unlikely to be of significant importance in the next decade even though the number of varieties available for purchase will increase markedly. Thus, once again it will remain the ethical responsibility of the seedling grower to counsel the buyer about appropriate seedlots to meet the buyer's needs.

Gene Conservation And Biodiversity

All forestry activities will continue to come under closer public scrutiny over the next decade. In tree improvement, this means the areas of gene conservation and biodiversity. Currently, there is the misconception that some industrial owners are practicing clonal forestry, i.e., the large scale planting of single genotypes. This is wholly untrue now and will continue to be untrue for the next decade in the southeastern United States. Some companies do plant half-sibling (also called mother-tree) family blocks of say 20 to 40 acres, but these are quite diverse, genetically, compared to varieties of agronomic crops.

Nevertheless, there will be increasing pressure to practice gene conservation within a species. I believe that the southeastern United States is doing an excellent job of gene/conservation for the commercially important tree species. The forest industry, through the three tree improvement cooperatives, retains hundreds to thousands of genotypes of the main pine species; and this is enough to serve an effective gene conservation role under most scenarios. Region 8 of the U.S. Forest Service is conserving genes from even a wider array of species.

In addition to gene conservation within a species the concept of ecological diversity (growing mixed species stands) may also make an impact in the next several years. Already, mixed species stands are promoted as wildlife plantings in some cost-share reforestation projects. This trend could mean that tree nurseries will have the opportunity to grow and market non-traditional species.

Biotechnologies

In the past ten years, research in biotechnology has escalated in all areas (forestry included) and this area of research will likely remain well-funded for the next decade. Biotechnology has already had a large impact in the medical sciences (e.g., synthetic production of insulin), and is beginning to impact some agronomic crops (e.g., development of a transformed strawberry variety with an inserted gene conferring frost hardiness).

How will biotechnology research impact forest genetics and nursery production in the

next decade? First, it seems quite likely that biotechnology research will lead to a greater understanding of the genetics and physiology of commercially important traits. For example, how many gene loci control growth or resistance to fusiform rust? Also, in the next decade genome maps showing locations of important markers may be developed to the point of having practical value in aiding selection.

However, these developments will not directly impact nursery production or management. And, is highly unlikely that a genetically-transformed variety carrying an inserted gene from some other organism will be into commercial production within the next ten years. One possibility in the next decade is the operational testing and perhaps commercial production of rooted cuttings. A recently established research project at North Carolina State University that is being funded by several forest industries is working towards commercial production of rooted cuttings of loblolly and slash pine. Slash pine, especially, seems quite well suited to production from rooted cuttings from juvenile material. This may either be based on a containerized or bare root facility, but seems feasible. It seems reasonable, therefore, that nursery growers may have the opportunity to participate in perfecting the cultural regimes necessary to grow rooted cuttings on an operational basis.

SUMMARY

Over the next decade there are several ways that tree improvement may influence nursery production and management. Geographic variation and seed movement will continue to be important issues and the number of different kinds of improved varieties will increase dramatically as third generation seed becomes available. Both of these issues impact nursery growers in a similar way. For nurseries servicing only company lands, nursery and silviculture personnel need to work closely to develop sowing schedules to ensure that seedlings from the proper seed sources and varieties are available to match reforestation needs. For seedlings being sold to non-industrial private landowners, an expert in the reforestation community (whether it be a county forester, extension agent, nursery manager, etc) needs to keep abreast of these issues so they may counsel the seedling buyer. At present, there does not exist a good mechanism of technology transfer to keep reforestation experts up-to-date on these forest genetic issues. I strongly encourage the development of such a technology transfer mechanism through which forest geneticists and nursery personnel work together to develop an effective method of counseling seedling buyers as to appropriate genetic stock to meet their reforestation needs.