FIFTY-THIRD

PROGRESS REPORT

OF THE

COOPERATIVE

FOREST TREE IMPROVEMENT

PROGRAM

By

T. D. Byram, L. G. Miller, and E. M. Raley

December 2005

TEXAS FOREST SERVICE
a Member of
The Texas A&M University System

An Equal Opportunity Employer

TABLE OF CONTENTS

INTRODUCTION

While the impact of Hurricanes Katrina and Rita on the tree improvement community was not widely reported in the media, the storms were still the most significant natural disaster ever experienced by members of the Western Gulf Forest Tree Improvement Program (WGFTIP). The two storms resulted in widespread damage to orchards, breeding programs, and progeny tests in the states of Louisiana, Mississippi, and Texas. Twelve orchard complexes suffered damage ranging in severity from losing only a few trees to the complete devastation of older production orchards. Katrina was the more damaging of the two storms in terms of the level of harm inflicted on individual orchards. Rita, however, impacted more tree improvement locations.

The eye of Hurricane Katrina passed near both Weyerhaeuser's Isabel orchard complex near Bogalusa, LA and the Mississippi Forestry Commission's Craig Seed Orchard at Baxterville, MS before bruising Plum Creek's Moselle, MS orchards. One unexpected advantage of the advancing-front orchard concept became apparent as the damage was tallied. Older orchard blocks were sometimes completely devastated while the younger orchard blocks survived relatively unscathed (Figures 1 and 2). As a result, no orchard complex with a range of orchard ages completely lost all future seed production capacity.

Figure 1. Mike Lee with the Mississippi Forestry Commission surveys the damage caused by Hurricane Katrina in a 10-year-old loblolly pine seed orchard block at the Craig Seed Orchard.

Figure 2. A six-year-old loblolly pine seed orchard block at the MFC Craig Seed Orchard that was relatively unscathed by Hurricane Katrina.

The impact of the orchard losses from Katrina was somewhat mitigated by the fact that the older orchard blocks of poorer genetic quality were scheduled for removal as younger blocks reached full production capacity. Loss of short and medium range seed production capacity, however, was considerable. Much of the 2005 cone crop, which was expected to break all previous records, was lost (Figure 3). The storm, occurring a month before the normal start of cone harvest, was too early in the season to allow cones to be collected from downed tops. The fact that food, fuel, drinking water, electricity, lift equipment, and in some cases shelter were in short supply over a large area drastically complicated the orchard clean-up that had to be completed before cone harvest.

Figure 3. Part of the slash pine cone crop lost to hurricane damage.

A month later, Hurricane Rita came ashore damaging trees in every single orchard complex in Texas. The damage extended from ETT, LP and the state of Louisiana's orchards near the Sabine River, west and north to International Paper Company's orchards near Livingston and Nacogdoches. In Louisiana, it damaged trees in orchards managed by Forest Capital Partners, LLC, and by the state of Louisiana in Beauregard Parish before extending the range of its impact to Weyerhaeuser's orchards at Taylor in the northern part of the state. The loss of orchard trees to Rita, while significant, was not as devastating as the damage further east from Katrina (Figure 4). This combined with the fact that the storm preceded the normal start of loblolly pine cone harvest by only about 10 days made it possible to pick cones from downed tops with the expectation that after-ripening would result in reasonable yields. This was still a very difficult task. Key people were displaced due to mandatory evacuation orders and in some cases not allowed back into the affected areas for some time. Personnel that were still in place were dealing with shortages of essential supplies for both themselves and their cone collection crews. In the case of the Texas Forest Service, Research Specialist Don Travis, Jr (Figure 5) was the only TFS employee that could reach the Magnolia Springs Seed Orchard for several days. Don organized the delivery of MREs (meals ready to eat), drinking water, and fuel for the cone collection crew and made it possible for the state to salvage a reasonable seed collection season.

In a story that has been repeated many times across the southeast in recent years, tree improvement personnel worked to meet the needs of their own families at the same time that they labored to restore their orchard operations. As phone service was restored, people called College Station to let us know that they, their crews, and their families were safe. Without exception,

Figure 4. Texas Forest Service loblolly pine orchard showing downed trees and broken tops suffered due to Hurricane Rita.

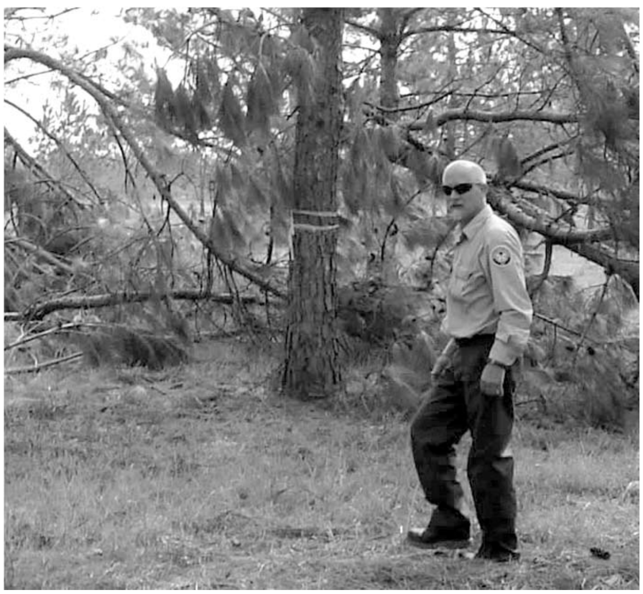

Figure 5. Don Travis, Jr. was the first Texas Forest Service employee to reach the Magnolia Springs Seed Orchard. Travis procured supplies for the collection crew and subsequently coordinated the 2005 cone harvest.

everyone wanted to know how the adjacent tree improvement programs faired and if there was anything they could do for their neighbors. People from many different organizations worked together to share limited resources. In just one example, Jim Tule with Temple-Inland Forest, who had the forethought to acquire a refrigerated trailer with fuel, was capable of storing research pollen and seed for nearby programs until power could be restored to their operations. Backup generators, fuel, and portable cold storage were especially important as both storms were followed by several days of near 100º F temperatures. Bucket trucks were loaned to allow control-pollinated cones to be collected. Arrangements were made to share contracted cone harvest crews to facilitate seed collection. Once again, the culture of collaboration in a cooperative program and the generous nature of many who work in tree improvement served the cooperative well.

Older slash pine seed orchards were particularly susceptible to bole breakage, perhaps because of larger crowns and more brittle stems (Figure 6). The damage to slash pine orchards impacted the cooperative in a number of ways. The proportion of the total slash pine seed production capacity lost was relatively larger than that for loblolly pine. This occurred for two reasons. First, slash pine is a relatively minor species in the region and is planted only in the lower coastal plain. As a result, there are fewer orchards for this species and all of them were in the impacted area. Secondly, because of the declining importance of this species in recent years, orchard replacements have been delayed or downsized resulting in the age distribution skewed toward the older orchard blocks that were more susceptible to windthrow and breakage. A more serious impact was on the breeding program. Because of the reduced need for slash pine seed, many of these slash pine seed orchards were being used in the breeding programs as the preferred locations for loblolly pine top-grafting and accelerated breeding. Many top-grafts with control-pollinated cones and conelets were damaged. The extent of these losses is still being tallied.

Figure 6. Mike Lee, Mississippi Forestry Commission, surveying the extent of stem breakage in an older slash pine seed orchard at the MFC Craig Seed Orchard. This orchard was subsequently abandoned.

The damage to the progeny testing program was also costly in terms of lost information and lost time. This was not because of the absolute numbers of tests damaged, but because of their ages and the fact that many were advanced-generation polymix progeny tests. The worst previous regional disaster was the ice storm of December 2000. This storm resulted in dropping far more progeny tests in Arkansas, Oklahoma, and northeast Texas than the combined total for both hurricanes Katrina and Rita. All of these ice storm damaged tests, however, were five years of age or older and had at least one growth evaluation prior to their destruction. No progeny tests were abandoned because of the ice storm before data was collected.

Some useful information will be recovered from the plantings damaged by the hurricanes. While there were some broken tops, most of the damage was lean due to windthrow (Figure 7). Many of the younger, leaning trees will undoubtedly recover (Figure 8). Many of the older tests were just reaching age four or five and because of broken and leaning trees, decisions may have to be based on family basal area growth rather than planted tree volume. Most of these plantings were loblolly pine polymix progeny tests established as part of the complementary mating scheme intended only to rank parental performance. Selections will be made from pedigree-controlled block plots, which as a rule, were younger and suffered less damage. Selection goals can still be met despite the damage to polymix progeny test plantings. The lower level of accuracy in estimating parental breeding values, however, will have to be mitigated by applying less selection pressure, making selections in more families, and testing more individuals in the next cycle of advanced-generation polymix tests.

Figure 7. Terry Rucker with Forest Capital Partners, LLC examines damage to a slash pine progeny test in southern Beauregard Parish, LA.

Figure 8. Jim Tule and Greg Garcia, Temple-Inland Forest, survey leaning trees in a young loblolly pine progeny test.

Despite the devastation from the hurricanes, there were highlights in 2005 as well. The cooperative made its initial third-cycle selections in the main-line breeding program with International Paper Company. Previous third-cycle selections have been identified in individual member's elite-breeding populations, such as the Texas Forest Service drought resistance program, but have not contributed to the mainline good growth and form population. This year's selections were noteworthy as they represented the first to be used as the foundation for reconstituting a breeding group for the third cycle of breeding. The term 'generation,' which has already lost much of its meaning in the deployment population, is proving to be even less useful in the breeding population. International Paper Company's advanced-generation Breeding Group 5 consists of the individuals with the highest breeding value regardless of the number of generations removed from the initial wild selection. This breeding group, therefore, now contains a mixture of first-, second-, and third-generation selections as well as some individuals that were chosen from crosses made between first- and second-generation parents. The next cycle will result in crosses among any number of generational combinations and among both unrelated and related parents. Ultimately, the only important factor for inclusion in advanced-generation breeding will be genetic value and the meaning of the word 'cycle' may become ambiguous as well. Initial attempts have been made at creating co-ancestry matrices for advanced-generation breeding groups to track relatedness and to help plan crossing programs. The objective will not be to avoid inbreeding, but rather to introduce it into the breeding program gradually.

The Western Gulf Forest Tree Improvement Program added the new membership category, Sustaining Member, in 2005. This was an attempt to broaden the cooperative's appeal to organizations that have not traditionally participated in the tree improvement program but have a vested interest in enhanced forest productivity and forest genetics research. This will make it possible to accommodate organizations that desire a higher level of participation than that granted to Associate Members, which are primarily service contractors, yet not require the commitment to breeding expected of a Full Member. Sustaining Members will have very limited access to performance data and no ownership of plant material. They will, however, be welcome partners in planning the program's future. ArborGen became the WGFTIP's first Sustaining Member. Indeed, they made their first major contribution to the program by helping develop this new category of membership through discussions held with the staff during the previous year. They are currently contributing to the cooperative by helping us plan for our role in southern pine clonal forestry.

The USDA Forest Service Southern Research Station continued to expand its presence at Texas A&M University and its collaboration with the WGFTIP. Laboratory renovations for the Forest Tree Molecular Cytogenetics Laboratory, a part of the Southern Institute of Forest Genetics, were completed. Dr. Nurul Faridi, upon unpacking his equipment, wasted no time in demonstrating the utility of fluorescent *in situ* hybridization (FISH) in forest trees. One of the first projects carried out in the new laboratory helped resolve mapping ambiguities in the Poplar Genome Project. He has also provided a scheme to standardize karyotyping of loblolly pine, discovered a previously unknown pine retrotransposon, and recently identified the physical location of a disease resistance gene, a task not previously accomplished in pine.

The Southern Institute of Forest Genetics added an additional professional to its College Station staff by transferring Dr. Jennifer Myszewski from Gulfport, MS. Dr. Myszewski's research is focused on the inheritance of wood quality and quantitative genetic variation in forest trees. She is particularly interested in collaborating with the cooperative in developing the tools that will allow rapid assessment of wood quality in standing trees on the scale required in tree improvement programs. She arrived in December and has already worked on a Temple-Inland project to assess acoustical conductance of 24-year-old loblolly and slash pine progeny tests prior to their harvest for a mill study. Wood samples were also transferred to Dr. Tom Elder of the USDA Forest Service Southern Research Station for additional physical characterization.

Highlights

- Hurricanes Katrina and Rita damaged 12 orchard complexes resulting in the destruction of 276 acres of older orchards that were subsequently removed from production. Younger blocks in advancing-front orchards were less damaged and will be intensively managed to offset the seed production losses.

- The 2004 seed crop was the first crop in the last seven years to be significantly below the member's annual demands. In 2004, 14,471 pounds of loblolly pine seed and 1,396 pounds of slash pine seed were collected.

- Slash pine first-generation breeding and testing was completed in 2005 with the establishment of the final test series by Temple-Inland Forest. This progeny test series included 24 families from two diallels of Breeding Group 12.

- The cooperative's initial third-generation selections in the mainline breeding population were selected with International Paper Company. These selections will reconstitute Breeding Group 5 for the next cycle of breeding.

- The collaboration between the Southern Institute of Forest Genetics (SIFG) and the Western Gulf Forest Tree Improvement Program was expanded with the completion of the laboratory renovation to house Dr. Narul Faridi and the Forest Tree Molecular Cytogenetics Laboratory. Dr. Jennifer Myszewski was also relocated from Mississippi to Texas A&M University which will further the partnership between the SIFG and the members of the WGFTIP.

Seed Orchards

Hurricanes Katrina and Rita damaged orchard blocks in twelve different orchard complexes across Mississippi, Louisiana, and Texas. Katrina caused the most severe devastation, passing almost directly over Weyerhaeuser's Isabel Orchard near Bogalusa, LA and the Mississippi Forestry Commission Craig Seed Orchard near Baxterville, MS before moving northeast and inflicting damage on Plum Creek's Moselle Orchard near Laurel, MS. Weyerhaeuser and the Mississippi Forestry Commission lost a combined total of 276 acres of orchard that were damaged to the point that they had to be abandoned. These were mostly older orchard blocks and in some cases had already been mothballed (Figure 9). Younger orchard blocks, primarily those below age 10, were only minimally damaged. These two complexes were left with 128 acres of loblolly and slash pine seed orchards under management. Seed was harvested in 2005 and these two orchard complexes will continue to support local reforestation programs.

Figure 9. One of the oldest orchards at the Weyerhaeuser Isabel Orchard site (Photo courtesy of Steve Smith).

Hurricane Rita caused less extensive damage, but impacted a larger number of orchard complexes. Damage in individual blocks within orchard complexes ranged up to an estimated 60 percent of the trees blown over or with tops broken out. No orchards, however, had to be abandoned because of this storm. Rita damaged orchards in southeast Texas, southwest Louisiana, and North Louisiana.

The advancing-front orchard concept was developed to rapidly capture gain from the breeding program and to move it into the production population by establishing small orchard blocks on a regular basis. The advantage of having orchard blocks with different ages to lower the risk of catastrophic loss was an unanticipated bonus. Despite the devastation caused by the hurricanes, no orchard complex was completely lost. In the short term, seed production capacity was curtailed, both due to orchard loss and because of damage suffered by individual trees. To meet the anticipated shortfall, it will be necessary to manage seed inventories, practice wise seed movement, and substitute species where appropriate. Experience from previous storms indicates that orchard trees recover quickly and seed production in reasonably stocked orchard blocks will be fully restored in a couple of years. Orchard replacement schedules will be accelerated to replace the orchards that have been lost. Plans for orchard expansions will be revised once the massive clean-up effort has been completed.

Orchard Establishment and Acres Under Management

Two organizations grafted new orchard blocks in 2005. Forest Capital Partners, LLC grafted 16 acres of loblolly pine orchard and the Mississippi Forestry Commission grafted 6 acres of slash pine orchard. The new Forest Capital Partners, LLC orchard block illustrated the flexibility of the advancing-front orchard. Until recently, the land base now owned by Forest Capital Partners, LLC was managed by Boise. Under this vertically integrated system, the seed orchard was designed to maximize the profitability of Boise's DeRidder, LA paper mill. Thus, significant weight was placed on specific gravity when selecting clones for the orchard. Under the new ownership, the final product is now stumpage and specific gravity has a much lower value. Therefore, new orchard blocks will emphasize improvements in volume and form while maintaining a threshold value for specific gravity. It was possible to rapidly respond to this new selection criterion by designing the newest orchard block with considerable gain in breeding value for volume. This 'mid-course' correction was done while maintaining the previously agreed upon orchard replacement schedule.

Removing the orchard acres lost due to the hurricanes and adding the acres grafted in 2005, members of the cooperative now manage 2,087 acres of orchard (Figure 10). Of this total, 893 acres are heavily rogued first-generation orchards and 1,194 acres are advanced-generation orchards. The number of advanced-generation orchards supplying seed to reforestation programs within the region is underestimated. Orchards established outside the region and orchards established within the region but with selections that are proprietary to individual members are not counted. Even without these uncounted orchards, advanced-generation orchards made up the bulk of the seed orchard acres. As advanced-generation orchards are preferentially collected because of their high genetic value, their impact on the regeneration programs is also under estimated.

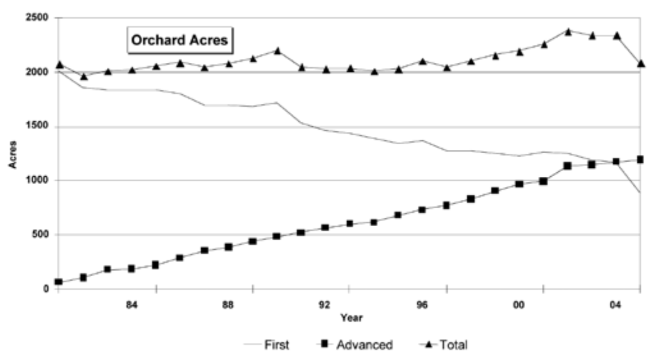

Figure 10. Seed orchard acres managed by the cooperative.

Three members established rootstock in 2005 for grafting loblolly orchards in 2006. These organizations included Deltic Timber Corporation, the Mississippi Forestry Commission, and Potlatch Corporation. The Texas Forest Service established Virginia pine rootstock and will begin grafting the first clonal seed orchard for this species selected for improved Christmas tree traits. This clonal orchard will replace a seedling seed orchard.

Orchard Yields

The 2004 seed yields were sufficient to meet only about half of the cooperative's annual demand for loblolly pine. Seed crops are extremely variable and the cooperative has been fortunate to have six years running in which the seed harvests have been more than adequate. In 2004, the cooperative harvested only 14,471 pounds of loblolly pine seed and 1,396 pounds of slash pine seed (Figure 11). The loblolly crop was only 44 percent of the ten-year average harvest. With only four organizations collecting slash pine, the 2004 harvest for this species was only 31 percent of the ten-year average. Seed yields were also below average with a yield of only 1.07 pounds of seed per bushel from the loblolly orchards and 0.74 pounds of seed from the slash pine seed orchards. In general, northern and eastern loblolly orchards within the WGFTIP region had good yields while loblolly orchards further south and west had poorer yields. Two members collected 636 pounds of longleaf pine seed from a seedling seed orchard and from progeny tests thinned for seed production.

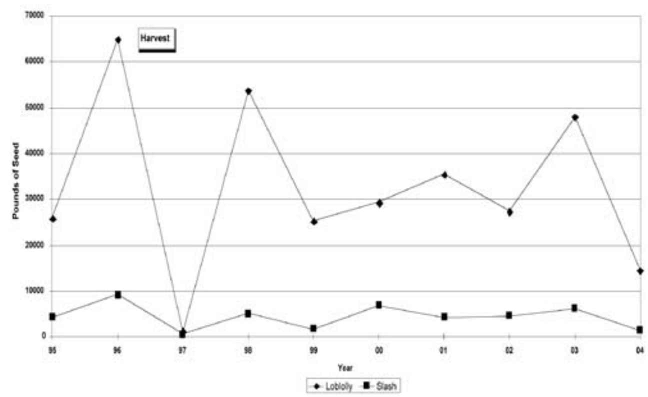

Figure 11. Pounds of seed harvested by the cooperative from 1995 to 2004.

The Texas Forest Service had such a poor cone crop that the decision was made to forego collection in 2004 and make up the difference in 2005 when the cone crop was expected to be outstanding. In fact, the cone crops across the southern part of the WGFTIP region were projected to break all previous records and several organizations, in addition to the Texas Forest Service, were anticipating that seed inventories would be substantially replenished with the 2005 harvest. This anticipated seed crop was also of high genetic quality as this was the first large collection in several young advanced-generation orchards. Unfortunately, much of this cone crop was never collected because of hurricanes Katrina and Rita.

The final tally for the 2005 harvest was 18,772 bushels of loblolly pine. In the southern part of the WGFTIP, many of these cones were collected from downed trees and seed yields are expected to be low due to case-hardening. After the storms, only four organizations were left with productive slash pine orchards. Three organizations collected 1,868 bushels for this species. As reforestation efforts begin in earnest along the Gulf Coast, these remaining slash pine orchards may increase in importance. Demand for slash pine could increase drastically if it is favored in the phosphorous-deficient flatwoods or if shortages develop in suitable loblolly pine seed sources. In addition, the cooperative collected 620 bushels of longleaf pine cones from seedling seed orchards, 250 bushels by the Mississippi Forestry Commission and 370 bushels by the Louisiana Department of Agriculture and Forestry. Small amounts of Virginia pine (10 bushels) and shortleaf pine (101 bushels) were also harvested.

That cones were harvested at all in the areas impacted by the hurricanes was a testament to the incredible determination and dedication of the seed orchard crews from a number of different organizations. There were power outages that lasted for weeks and shortages of food, fuel, and drinking water. Lift equipment was diverted to clearing power lines and ground access in the most heavily damaged orchards was arduous. In addition, almost everyone had damage to their own homes and communities. Despite these difficulties, a combined total of 2,732 bushels of cones were collected from the three orchards hardest hit by Katrina: Weyerhaeuser's Isabel Orchard near Bogalusa, LA, the Mississippi Forestry Commission Craig Seed Orchard, and Plum Creek's Moselle Orchard. In the western part of the WGFTIP region, six organizations collected 5,817 bushels of cones in the hardest hit area immediately after Rita passed (Figure 12). These cones were collected by International Paper Company, Forest Capital Partners, LLC, Louisiana Department of Agriculture and Forestry, Temple-Inland Forest, the Texas Forest Service and Hancock (formerly ETT, LP). This was less than half of the predicted harvest.

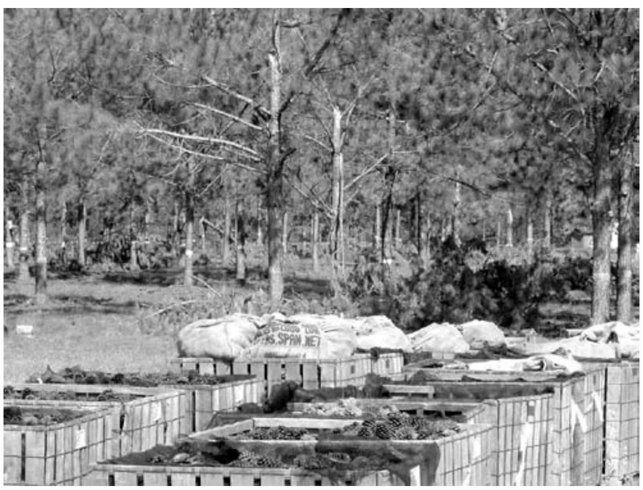

Figure 12. Cone collection in Temple-Inland's Forest Lake Orchard proceeds despite the broken tops evident in the background.

Deployment Population Screened for Pitch Canker Resistance

Pitch canker (*Fusarium subglutinans*) is an endemic disease over much of the southern pine range causing lost growth and degrade in form due to die back of terminals and primary branches. While capable of causing mortality, the disease seldom expresses itself to this extent in the Western Gulf region and is generally considered more of a nuisance than a real threat to productivity. Conditions for disease expression, however, were optimal in southeast Texas and southwest Louisiana in 2003 and 2004. Pitch canker outbreaks were reported in plantations ranging in age from five to 18 years and in both fertilized and unfertilized stands. Initial outbreaks were observed in loblolly pine plantations and only later seen in adjacent slash pine plantations leading to the speculation that the disease was being spread by an insect vector with a feeding preference on loblolly pine. The severity of the outbreak was sufficiently severe to result in virtually no growth in an 18-year-old stand that was monitored annually over a three year period (Figure 13). Such a large number of stems were infected in one five-year-old loblolly pine progeny test that no second-generation selections could be identified. Examination of planting records showed that some open-pollinated family blocks appeared to be more heavily infected than did others, implying that the pattern of the outbreak was at least partially under genetic control. Lack of common garden comparisons and insufficient replication in the field made this conclusion tenuous at best.

Figure 13. Pitch canker outbreak in southwest Louisiana.

As the Western Gulf region has not had sustained outbreaks of pitch canker in the past, very little is currently known about the resistance of our deployment population. In order to determine if useful levels of resistance existed in the current deployment population, open-pollinated orchard seed was collected from a total of 71 loblolly pine families and submitted to the USDA Forest Service Resistance Screening Center for the assessment of family level resistance. This was a joint effort of the cooperators planting seedlings in the impacted areas of southeast Texas and southwest Louisiana and included families collected by International Paper Company, Temple-Inland Forest, the Texas Forest Service, Forest Capital Partners, LLC, and the Louisiana Department of Agriculture and Forestry.

There were significant differences among families in the percentage of inoculated seedlings with more than 50 percent of the stem infected, ranging from 0 to 62 percent (Figure 14). All of the WGFTIP families had less infection than did the susceptible check which had 95 percent of the trees with 50 percent or greater stem infection. In fact, all but three families had half as many or fewer of the trees infected than did the susceptible checklot. The susceptible checklot in this study was a slash pine family, as the RSC has not had a great deal of past experience in testing for resistance in loblolly. The families in this study represent the fastest growing and most commonly deployed families in the region. Because of their outstanding breeding values, they have also contributed heavily to the next cycle of selections in the breeding population. Therefore, this resistance is being captured in both the deployment population and in the breeding program.

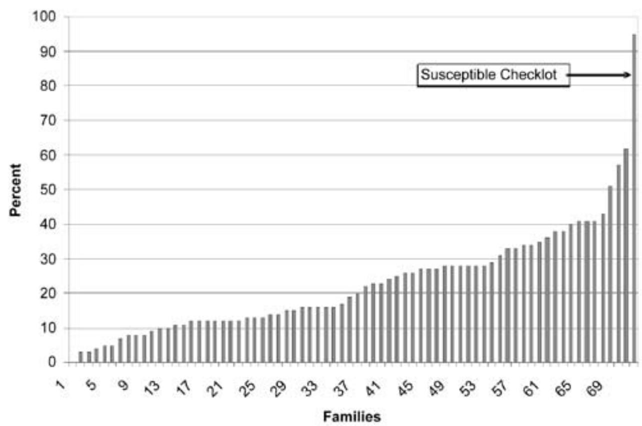

Figure 14. Results from the pitch canker assessment at the Resistance Screening Center for the southwest Louisiana and southeast Texas deployment population.

Past pitch canker outbreaks have been episodic and the disease is much less prevalent in 2005. The incidence of the disease will be monitored to determine if pitch canker resistance should be added as a selection criterion when designing orchards or for selecting the breeding population. If the disease becomes an important problem, there appears to be exploitable levels of resistance in the current highly-selected deployment population.

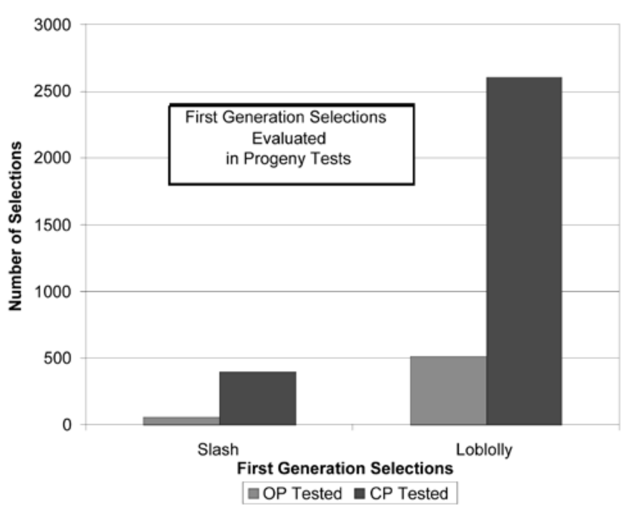

Figure 15. Numbers of selections in the base population for the loblolly and slash pine breeding populations showing the proportion tested in open- and control-pollinated progeny tests.

First-Generation Breeding and Progeny Testing

First-generation breeding and progeny test establishment was completed for loblolly pine in 2004 with the exception of one diallel by location combination of loblolly pine that has yet to be planted. Slash pine first-generation breeding and progeny test establishment was completed in 2005 with the planting of the final test series by Temple-Inland Forest. This series included 24 families from two diallels of Breeding Group 12. These families were created from crosses with the last of the rust resistant parents identified from the approximately 1,000 first-generation selections submitted to the USDA Forest Service Resistance Screening Center.

The members of the cooperative have now established a total of 3,123 loblolly pine and 464 slash pine first-generation parents in long-term progeny tests to evaluate growth, form, and wood quality (Figure 15). While it is possible that infusions will be added to support new breeding objectives or to capture genetic variation from other regions, the first-generation breeding population is now essentially closed. The first-generation parents under evaluation and their progeny represent the base population to which the all future populations will be related. The first-generation progeny testing program is now focused on the measurement of established plantings and the identification of the additional second-generation selections needed to reconstitute the population for the next cycle of breeding.

First-Generation Test Measurement and Second-Generation Selection Activity

During the 2004/05 measurement season, the cooperative measured 119 progeny tests. Three of these were holdovers from the 2003/04 season. In all, 84 of the 119 progeny tests were loblolly pine, 12 were slash pine, 12 were Virginia pine and six were longleaf pine. In addition, 10-year measurements were taken on the four remaining installations of the slash pine hybrid study.

Tests grouped by measurement age included the following evaluations. Survivals were assessed in 14 tests. There were 17 five-year-old tests, including one shortleaf pine polymix test and two East Texas loblolly pine polymix tests. As a result of these fifth-year measurements, performance rankings became available for an additional 60 East Texas loblolly pine crosses and their 30 first-generation parents. Information was also made available for 69 new slash pine families and the 35 parents that contributed to this population. The bulk of the test measurement load was age-10 tests, totaling 53 of the 119. Fourteen tests were measured at age 15 and three tests received their final measurement at age 20.

Cooperators screened 120 control-pollinated families and identified 78 new second-generation selections in 2005. Of these, 58 were loblolly pine and 20 were slash pine. The greatest number of new loblolly pine second-generation selections that were made with a single cooperator was 16 identified with Forest Capital Partners, LLC. Plum Creek

Timber Company ran a close second with 15 new selections from South Arkansas and International Paper Company added ten new selections to their Texas program. Forest Capital Partners, LLC also led the effort in slash pine with 18 of the 20 new slash pine second-generation selections. The cooperative has now identified a total of 1,633 loblolly pine and 245 slash pine second-generation selections (Figure 16). A sufficient number of selections have been made to reconstitute 60 of the cooperatives original 113 loblolly pine breeding groups for the next cycle of breeding. Completing the selection efforts in the remaining groups or combining groups that have produced few outstanding selections will be a high priority in the next few years.

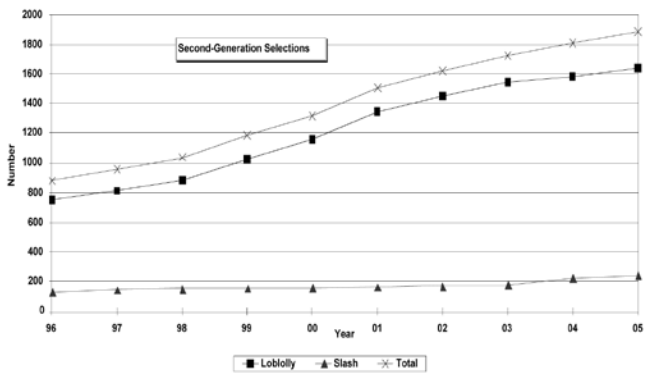

Figure 16. Cumulative number of WGFTIP second-generation selections.

Slash Pine Hybrid Study

The University of Florida Cooperative Forest Genetics Research Program (CFGRP) established a series of field plantings in 1994/95 to evaluate the growth potential of hybrids formed between *Pinus elliottii* and two varieties of *P. caribaea* and a loblolly by slash pine cross. The CFGRP graciously provided seed to the WGFTIP for the establishment of five studies in the Western Gulf region. Temple-Inland Forest maintains one test in Hardin County, TX, the Louisiana Department of Agriculture and Forestry maintains one test in Beauregard Parish, LA, and the USDA Forest Service maintains one test in Grant Parish, LA and one test in Harrison County, MS. A single test maintained by Boise Cascade was lost to fire in 2000. All test locations in the Western Gulf region were comprised of five taxa: the Western Gulf unimproved slash checklot (WG), improved WGFTIP slash (IMP), slash x loblolly (LOB), slash x *P. caribaea* var. *bahamensis* (PCB), and slash x (slash x *P. caribaea* var. *hondurensis*) (F1H). Each test consisted of three replications of 48 or 49 sources planted in five-tree-row plots. Tests were established with a split-plot design with taxa as the main plot and families-within-taxa as subplots.

In 1997, two-year results for height and survival were reported in the 45th Progress Report of the Cooperative Forest Tree Improvement Program for the four tests in Louisiana and Texas. Fifth-year results for survival, fusiform rust infection, height, diameter and volume were reported for four of the five locations (including only the USFS LA test) in the 48th Progress Report of the Cooperative Forest Tree Improvement Program in 2000. The four tests remaining after the loss of the Boise installation have reached ten years of age and were evaluated for survival, height, diameter, volume, and fusiform rust infection. Results for these four locations are reported here.

Average survival at age 10 of all sources in individual tests ranged from 46 to nearly 73 percent with an average survival across all four locations of 64 percent. Fusiform rust infection in individual tests ranged from 31 to nearly 61 percent with an across-location average of 46 percent. Average volume growth in individual tests was extremely variable, ranging from 5.8 m^3/ha/yr at the USFS location in MS to 13.9 m^3/ ha/yr at the Louisiana Department of Agriculture and Forestry location. The average over all four locations was 8.6 m^3/ha/yr.

When each test was analyzed separately, significant differences among taxa were found for survival, volume growth, diameter, and fusiform rust infection at all four locations. Differences among taxa for height were significant at all locations except the USFS MS site. When all tests were analyzed together, significant differences among taxa were found for all traits. There was also a statistically significant interaction between location and taxon for all traits, but this was due to changes in rank based on relatively small differences and did not appear to be biologically important.

In general, the hybrid taxa performed poorly compared to the pure species taxa (Figure 17). The PCB hybrid had the highest level of rust infection and the smallest volume at every location. The IMP source had the lowest level of rust infection and the best survival at every location. However, the LOB hybrid had both the tallest individual trees and trees with greatest average diameters at all locations and would have ranked higher for volume had it not suffered rust-related mortality. The LOB hybrid at the TX location had more average volume than either the IMP or WG sources, although the differences were not statistically significant. In this test the top seven families for volume were LOB hybrids, with four of those above average for all traits. In the three other tests, the top two families for volume were also LOB hybrids, but all were plagued with above-average rust. However, individual rust-free selections may be possible.

The results concur with the five-year results in that there is no advantage to planting Caribbean slash pine hybrids in the Western Gulf region. They have proven to be highly susceptible to both fusiform rust and frost damage.

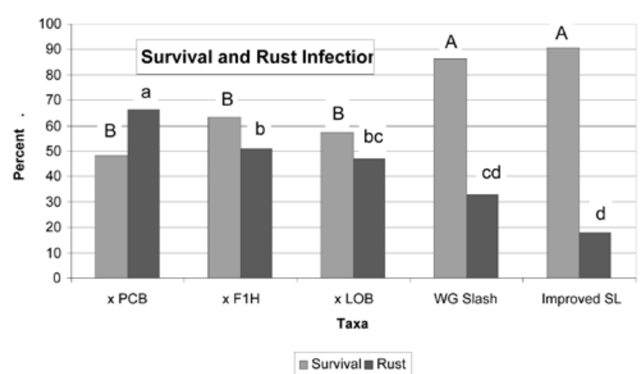

Figure 17. Average performance for the taxa in the slash pine hybrid study at age 10. Bars with different letters represent values that are statistically different at the 10 percent level of confidence. Capital letters compare survival and lower case letters compare rust resistance.

Opportunities, however, may exist within the loblolly hybrid population to use individual clones that appear to combine good growth acquired from loblolly pine with outstanding form from the slash pine parents. Some form of vegetative propagation would appear to be needed to deploy hybrid individuals with superior genotypes as the crosses have too much variability to be directly useful.

Ice Damage in Loblolly Pine Progeny Tests

In December of 2000, regions of Arkansas, Oklahoma, Louisiana, and Texas experienced record-breaking ice storms. This left many progeny tests in those areas with trees suffering from lean or broken tops. The damage was so extensive in Oklahoma that all progeny tests plantings age five and older were immediately dropped from the program. Fortunately, all of these tests had been measured at least once so there was no loss of information. In some instances, however, screening for second-generation selections were delayed to allow trees time to recover.

International Paper Company had completed measurement of its tests in Lafayette and Columbia Counties in Arkansas and in Webster Parish in Louisiana prior to the ice storms in the early winter of 2000/01. The decision was made in follow-up visits to maintain these tests and make a final decision whether to keep or abandon these tests just prior to their next measurement cycle. The tests were reviewed in the late summer of 2005 and were deemed measurable with little remaining evidence of the ice damage. However, in addition to the standard measurements, top breakage and straightness score were also assessed. By comparing measurements taken both immediately before the ice storm and five years later, we hoped to determine the impact of the ice damage on height and stem form assessment. More importantly, given the number of storm damaged progeny tests currently in the cooperative we hoped to determine whether the damage impacted the ability to accurately rank families for volume.

The tests in Lafayette County, AR consisted of a set of four tests which were 11 years old at the time of the ice storms and another two which were six years of age when the ice damage occurred. The test in Columbia County, AR and the four in Webster Parish, LA were also at the end of their sixth growing season when the ice hit. Therefore, there were four 15-year data sets and seven 10-year data sets to compare to earlier measurements.

The 15-year-old tests in Lafayette County, AR had broken tops in 40 percent of test trees. At age 15, the coefficient of variation (CV) for straightness score increased by only two percent. Mean rust infection increased by ten percent. However, the increased infection may have little to do with the damage caused by the ice storms and may have simply been the result of advanced gall development making the infections more observable. New infections observed at age 15 were equally divided between new stem galls and new limb galls. The same pattern was observed in the ten-year-old tests. The three tests in South Arkansas averaged only 16 percent top breakage, but the CV for straightness score increased five percent from age 5 to age 10. Rust infection also increased five percent with nearly 50 percent of new infections scored as limb galls. In the four ten-year-old Webster Parish, LA tests, mean top breakage was 35 percent. The CV for stem straightness increased ten percent. Mean rust infection increased 14 percent with nearly 60 percent of the new infections scored as limb galls.

Based on the number of broken tops still evident five years later it is very likely that the ice storms did indeed impact height growth assessment. The increase in CV for straightness score also suggests that it was more difficult to find a truly straight tree after the ice than before. It is less clear as to whether the ice storms impacted rust infection or whether increases in rust incidence was observed because of rust gall development.

To evaluate the reliability of the family rankings and the potential negative influence of the top breakage, basal areas differences were analyzed. Families rankings were then compared to those obtained using the standard volume analysis both at the current and previous measurement cycles. The family rankings based on basal area and those based on volumes were very similar (Table 1). This was despite the fact that the top families for volume at the earlier measurement ages on occasion had very high levels of top breakage.

These results demonstrate that progeny tests installed with the randomized complete block progeny test design can suffer considerable physical damage and still provide useful information. This strength comes partially from the robustness of the randomized complete block design and partially from the choice of traits on which growth assessments are based. Volume per planted tree combines information on diameter, height, and survival. Environmental damage to a single component of this composite trait introduces noise but does not necessarily drown out the signal, and the ability to rank parents is still intact. The cooperative is facing similar challenges as progeny tests recently impacted by hurricanes Katrina and Rita are analyzed.

Table 1. Pearson rank correlations among families for traits measured immediately before and five years after extensive ice damage. All correlations are significant at the 10 percent level unless indicated with ns.

Test	Age at Last Measurement	Trees with Ice Damage (percent)	Early/Late Volume	Early Vol / Late Basal Area	Late Vol/ Late Basal Area	Ice Damage / Late Vol
607	15	35.2	0.97	0.97	0.99	-0.61
615	15	41.5	0.96	0.95	0.99	-0.62
620	15	45.4	0.96	0.96	0.99	ns
622	15	37.9	0.95	0.95	1.00	-0.44
903	10	45.0 (ns)	0.89	0.80	0.97	ns
907	10	31.8	0.92	0.91	0.99	-0.35
909	10	20.5	0.94	0.93	0.99	ns
911	10	26.1	0.88	0.85	0.99	-0.31
913	10	11.4 (ns)	0.88	0.86	0.97	ns
914	10	17.1	0.87	0.83	0.98	ns
927	10	36.1	0.85	0.84	0.99	ns

Virginia Pine

The Virginia pine program is evaluating progeny from second-generation parents for survival and height growth at ages one, two, three, and four. In addition, Christmas tree quality is evaluated at age four. Second-generation parents in these tests were originally selected from progeny tests and provenance trials established in Texas and Oklahoma, and represent the beginnings of a land-race for this exotic species. Improved survival and growth rate are important selection criteria as this species naturally grows under very different conditions in the highlands of Alabama, Tennessee, and Georgia north through to Pennsylvania. To date 53 of the 110 selected parents have now been established in 13 progeny tests with the collaboration of Christmas tree growers in the states of Oklahoma, Texas, Louisiana, and Mississippi (Figure 18). The Texas Forest Service planted tests in the third Virginia pine test series in 2004. Oklahoma Department of Agriculture, Food and Forestry held their seedlings over the winter because of their small size and planted tests for the third series in 2005. Polymix seed harvests for 2005 suggest that the fourth test series with approximately 28 parents may be ready for establishment in 2006/07.

The states of Louisiana, Oklahoma and Texas have maintained and measured Virginia pine Christmas tree progeny tests annually for the past four years (Figure 19). Based on their performance in these plantings, outstanding parents will be grafted into the first clonal orchards for this species in the WGFTIP program by the Texas Forest Service in the spring of 2006. This clonal orchard will replace an aging seedling seed orchard that was destroyed by Hurricane Rita. The large, full crowns were unable to withstand the force of the wind and only three trees were left standing. Even before the storm, this orchard had been steadily loosing vigor and experiencing increasing levels of mortality. Therefore, advancing-front orchards appear to be necessary for this species as orchard trees appear to have a life span limited to less than 20 years in the Western Gulf region.

Figure 18. Joe Hernandez measuring a four-year-old Virginia pine Christmas tree at Dr. James Robinson's tree farm near Kilgore.

Figure 19. Landowner, Charles Grethen, and Justin Jones of the Oklahoma Department of Agriculture, Food and Forestry in Virginia pine test 1120 at age four.

Second-Generation Breeding and Testing

The cooperative's emphasis on breeding and progeny test establishment have not diminished with the completion of the first-generation breeding program but the focus has shifted. The current program is now concentrated on the implementation of complementary breeding schemes for the second- and third-generation populations. This includes polymix crossing for the establishment of regional good growth and form tests and pedigreed crosses from which advanced-generation selections will be identified. To date, the cooperative has established polymix plantings to evaluate breeding values for 750 of the 1,970 loblolly pine and 45 of 287 slash pine parents identified to be tested in the second-generation population (Figure 20). In the future, polymix crosses will also be used to evaluate selections from the super-breeding groups and wood quality elite populations as well. In addition 557 pedigreed crosses have been established in block plots to form part of the population for the next cycle of selection. These pedigreed crosses support the forward selection program in the main-line breeding program, and the backward selection program intended to supply exceptional individuals for the deployment population in the super-breeding group program and the Wood Quality Elite program.

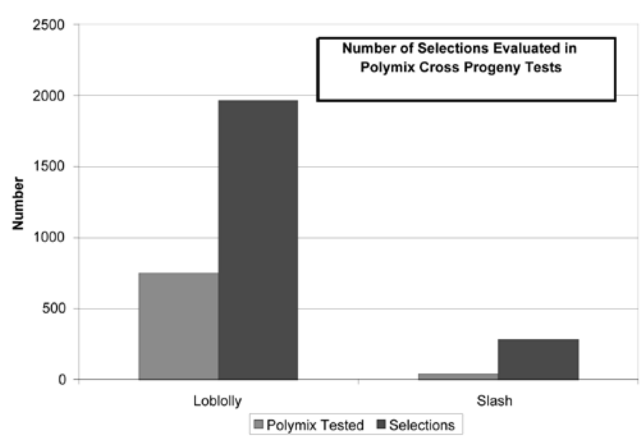

Figure 20. Progress in establishing polymix progeny tests for second-generation selections and the best first-generation selections that will reconstitute the population for the third cycle.

The cooperative's initial third-generation selections in the mainline breeding population were selected with International Paper Company in 2005 (Figure 21). These selections were made to reconstitute Breeding Group 5 for the third cycle of breeding. The term 'generation' which has been problematic in accurately describing the deployment population will be even more inaccurate in describing the breeding population. Breeding Group 5 was reconstituted with high breeding value individuals regardless of the generation from which they originated. The breeding population for the next cycle in this group contains first-, second-, and third-generation selections as well as selections from crosses between first- and second-generation parents. The selection population for the next cycle will be created by crossing individuals to maximize breeding values without regard to generation. By the fourth cycle, the term 'generation' will be virtually meaningless and demonstrated progeny test performance will be the only useful description of genetic potential.

Second-generation breeding and testing continues to be conducted on a regional basis. Each member is grafting an breeding second-generation selections belonging to breeding groups for which they have responsibility. Once polymix seed is in hand, production and planting of progeny tests series is done collaboratively on a regional basis. The chief advantage of this strategy is the ability to deploy progeny tests rapidly.

Figure 21. Greg Leach and Wesley McMullen, International Paper Company, collect scion material from one of the initial third-generation selections identified within a block plot.

During 2004/05 two series of polymix tests were planted (Table 2). International Paper Company, Temple-Inland Forest, and the Texas Forest Service collaborated to establish an East Texas loblolly pine polymix test series with 55 families. This was the second planting of an East Texas polymix progeny test series in as many years. An Arkansas/Oklahoma loblolly polymix test series was also established in 2004/05. This was also the second polymix tests series planted for this region in as many years. The Arkansas Forestry Commission, Potlatch Corporation, and Plum Creek Timber Company each established a test containing 77 families. Because extra seedlings were available a fourth location containing 66 families was planted by the Mississippi Forestry Commission in North Mississippi. Planting additional polymix progeny tests in adjacent deployment zones and the inclusion of extra families from neighboring zones in local test series will be done whenever possible to gather information on seed movement. To date, 1003 selections have established in polymix tests.

Table 2. Progeny tests established during the 2004/05 planting season.

Advanced-Generation Polymix Tests	Number of Tests	Number of Families
Loblolly Pine		
Arkansas Forestry Commission	1	77
International Paper Company	1	55
Mississippi Forestry Commission	1	66
Plum Creek Timber Company	1	74
Potlatch Corporation	1	77
Temple-Inland Forest	1	56
Texas Forest Service	1	55
Virginia Pine		
Oklahoma Dept of Ag. Food and Forestry	1	17

The second part of the advanced-generation breeding program is the establishment of pedigree crosses to form the selection population for the next cycle of breeding. These crosses are being planted in unreplicated block plots containing either 100 trees at one location or 49 trees divided between two locations. Crosses are being done at random as soon as flowers and pollen are available. While this strategy should shorten the time frame between the second and third cycle, in most cases the matings are made with untested parents. The drawback to this strategy is that some crosses will undoubtedly be made between poor parents as latter determined by performance in polymix progeny tests.

In 2005 the cooperative altered the pedigree program by dropping the random crossing scheme in favor of delaying crosses until some performance information is in hand. An additional height measurement at age three was added to the current evaluation scheme in which volume is first evaluated at age five. This information will be used to select parents in the top half of the population with the expectation that they are likely to have higher breeding values for volume. Initial crossing will concentrate on these parents until fifth- year volume growth data become available. At that time, the parents in the crossing scheme will be reevaluated and crosses will be added or deleted as dictated by the later performance data. Establishment of future block plantings may be delayed slightly, but costs will be reduced because fewer non-productive blocks will be established. Gain per unit time may also be better, although this has not been rigorously shown, as the probability of making matings with higher mid-parent values will be increased. For this strategy to be effective, measurements must be taken, analyzed, and results returned to the cooperator in time for pollen collection in the same year.

The Arkansas Forestry Commission, International Paper Company, and Potlatch Corporation evaluated height in a South Arkansas polymix test series to access the feasibility of taking this additional measurement (Figure 22). Analysis determined that families could be reliably ranked for height growth across locations. This data was then used to design the crossing scheme for these parents in the spring of 2005. This change is in line with the cooperative's long standing tradition of continuously reviewing the progeny testing program in order to make it both more effective and efficient.

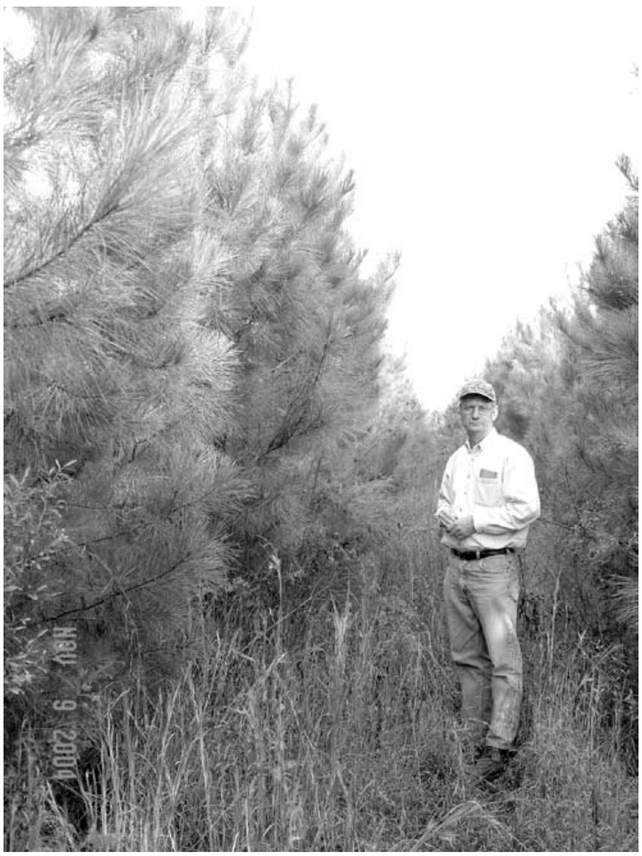

Figure 22. French Wynne, Potlatch Corporation, standing in a three-year old loblolly pine polymix test that was evaluated for height growth to design initial pedigree crossing schemes. Average height growth on the bedded portion of this test was 3.6 m (11.8 ft).

Members with seed already in hand from completed pedigree crosses will establish these into block plots. In 2004/05, four cooperators established block plots. In total seven cooperators have established selection plots for 525 control-pollinated families for both the loblolly and slash pine programs.

Third-Cycle Breeding

In 2005 the first third-cycle selections were made in International Paper Company block plots. In all five sets of block plots in both Arkansas and Louisiana were visited, where a total of nine families belonging to Breeding Group 5 (BG 5) were screened and a total of 16 selections were made. In the selection process, ranking parents based on performance in polymix progeny tests can be done with confidence. Within-family selection in block plots is inherently much more difficult and more imprecise for traits with low to moderate heritabilities and large environmental variation. To counter this difficulty, the cooperative has set a target of identifying three selections per family with the expectation that subsequent polymix progeny testing will be required to identify the individuals with the best genetic package. These selections will be grafted for preservation and top-grafted for accelerated breeding. Polymix crosses will be used to evaluate parental breeding values and pedigree crosses will be made to create the selection population for the fourth cycle.

Both backward and forward selections were used to reconstitute BG 5 to ensure that it would have individuals with the highest possible proven and predicted breeding values. As a result, the third cycle of breeding in BG 5 will include first-, second-, and third generation selections as well as some selections from crosses made between first- and second-generation parents. Tools such as coancestry matrices will be used to track relatedness that will occur in such complex breeding populations. Crossing among related individual will be performed on a limited basis in order to allow inbreeding to be introduced gradually in the breeding population. Seed orchards will continue to be designed by selecting unrelated individuals from different breeding groups to insure that seed for operational plantings are outcrossed.

Three cooperators have block plots scheduled for screening in 2006, with the potential to add 36 new third-cycle selections. Block plots will be screened with International Paper Company, Plum Creek Timber Company and Potlatch Corporation.

Additional Activities

Contact Representatives' Meeting

The annual Contact Representatives' Meeting was held May 17-18, 2005 at DeGray Lake Resort State Park near Arkadelphia, AR. Potlatch Corporation served as the host for the meeting and field trip, which was to their curved-saw sawmill near Prescott. Some of the topics covered at the meeting included forest inventory and analysis (Tony Johnson – USDA Forest Service), water quality and BMP issues (Hughes Simpson – Texas Forest Service), tree improvement and the non-industrial private landowner (Teddy Reynolds) and clonal testing designs (Dr. Dudley Huber). Mike Weatherford, Environmental Management System Manager for Potlatch, discussed forest certification systems and described the processes by which Potlatch received FSC certification for their southern lands and several mill operations.

Dr. Alex Mangini discussed pest management issues including potential new seed orchard chemicals, the recent pitch canker outbreak in southeast Texas and southwest Louisiana, and a status update on sudden oak death. Dr. Jim Guldin with the USDA Forest Service Southern Research Station in Hot Springs, AR presented information on a local pest, the red oak borer, and described the impact of this pest in the interior highlands of Arkansas, Missouri and Oklahoma. Wood quality assessments and a demonstration of standing tree stiffness evaluations were presented by Dr. Gary Peter of the University of Florida. The field trip was hosted by Potlatch Corporation with a tour of their Prescott Mill which represents the solid wood customer for much of the output from the tree improvement programs (Figure 23).

Figure 23. Members of the cooperative overlooking the initial handling equipment feeding the Potlatch Corporation's Prescott Mill. This was one of the first facilities in our area with a curve saw to maximize yield from small logs.

A social and dinner, arranged by the Texas Forest Service, were held at a pavilion on the lake. Attendees were joined at supper by several old friends from the region, including Dick Welch, Ron Campbell, Claude O'Gwynn and Leon Burris. Attendees received 7.0 continuing education credits from the SAF.

Seed Orchard Pest Management Subcommittee

The WGFTIP continued to work with and through the Seed Orchard Pest Management Subcommittee of the Southern Forest Tree Improvement Committee to meet the industry's needs for cone and seed insect control methods. This included supporting registration for existing chemicals as well as advancing ongoing research into new chemicals and novel integrated pest management techniques.

The entire forest tree improvement community has invested a great deal of effort in attempting to maintain the registration for azinphosmethyl. Guthion®[1] is the only organophosphate pesticide to show efficacy against coneworms, and because of its low impact on important insect predators, is recognized as an important part of an integrated pest management strategy. Unfortunately, it has also been involved in some high profile environmental accidents resulting in large fish kills when misused in an entirely different agricultural setting.

The struggle to maintain the seed orchard registration for azinphosmethyl has highlighted almost every single problem the tree improvement community has with obtaining effective chemicals for cone and seed insect control. Because of the limited number of acres treated, the chemical companies have little economic incentive to support registration. When they are convinced that the crop at risk has a very high economic value, they then question why we, as an industry, are unwilling to pay substantially more for their products. The Environmental Protection Agency's dual responsibilities to promote worker safety and to protect endangered species have also resulted in an uncertain regulatory environment, with the EPA favoring first one then the other as its chief concern with continued azinphosmethyl registration. Finally, the attempts to provide accurate and timely information to the EPA have highlighted both the strengths and the weaknesses of our abilities to do research in our orchards. A reduction in application rates for azinphosmethyl was justified on the basis of one of the largest southwide efficacy studies ever organized. This large study required installing incomplete experimental blocks in orchards scattered across the entire southeastern United States operated by organizations belonging to all three tree improvement cooperatives. This study was a tribute to our ability to work together. Recent attempts to conduct foliar residue studies have been less successful because of biology. Orchards are large and unwieldy experimental units with highly variable annual crops. The uncertainty of the cone crop has scuttled our best laid plans delaying the study a year at a time. This year, with five orchards committed to foliar sampling and a record cone crop we felt certain of success. Unfortunately, the study was derailed by not one, but two hurricanes.

Members of the cooperative continue to make orchards available to the entomology community for research into cone and seed insects. During the past year, Dr. Alex Mangini worked in the Plum Creek Hebron Orchard to evaluate the efficacy of two insect growth inhibitors: novaluron and diflubenzuron. Dr. Don Grosman continued to evaluate injection systems using emamectin benzoate and fipronil treatments. These studies were conducted across orchards in both the southeast and the Pacific Northwest. Participants in our area included Plum Creek Timber Corporation and Temple-Inland Forest.

The good working relationship between the entomology community and the orchard managers established through these ongoing research programs was extremely helpful after the hurricanes. Initial fears were that due to the number of downed and damaged trees, that bark beetles might be a serious secondary threat. The entomologists working in cone and seed insect research were quick to offer advice, assistance in monitoring, and access to stockpiled chemicals for control of any outbreaks, services for which the cooperative is genuinely grateful. One of the highest priorities following the storm was sanitation, which should ameliorate the threat of bark beetles. However, due to the amount of damage across the region and the mild winter conditions, this is a dangerous situation that will require careful monitoring during the coming summer.

[1] Mention of trade names is solely to identify material and does not imply endorsement by the Texas Forest Service or the Western Gulf Forest Tree Improvement Program, nor does it imply that the discussed use has been registered.

Formal Reviews

Formal Reviews were completed for Deltic Timber Corporation, Forest Capital Partners, LLC, the Louisiana Department of Agriculture and Forestry, the Mississippi Forestry Commission, and Temple-Inland Forest in 2005. These program reviews continue to meet two objectives. First, they focus on the organization's progress toward meeting their individual tree improvement objectives and obligations. The formal review is both retrospective, looking at the progress made in the past three years, and proactive, planning for the next three years. A second and equally important part of the process is obtaining feedback from the members on how well the Cooperative is functioning in support of their programs. This second objective is becoming both more important and more difficult as different types of organizations join the cooperative. The 2005 reviews were conducted for two state agencies, two integrated forest industries, and one timber investment management organization (Figure 24). Formal reviews scheduled for 2006 include a state forestry organization, a forest regeneration company producing clonal varieties, a timber investment management organization, and an integrated forest industry. Each organizational type has different criteria by which they judge success. It is becoming increasingly apparent that even members within the same organizational categories also have different criteria by which they judge their investments. The feedback obtained from the formal reviews will play a key role in helping the cooperative meet today's challenging environment.

Figure 24. Charles Matherne, Louisiana Department of Agriculture and Forestry (LDAF), Larry Miller, WGFTIP Staff, and Van Hicks, LDAF survey orchards damaged by Hurricane Rita during the Formal Review of their program.

USDA Forest Service Southern Institute of Forest Genetics

Two steps were taken this year to strengthen the collaboration between the Southern Institute of Forest Genetics (SIFG) and the Western Gulf Forest Tree Improvement Program. The first step was the renovation of the laboratory to house Dr. Narul Faridi and the Forest Tree Molecular Cytogenetics Laboratory (Figure 25). This work was essentially completed and the lab is now up and running. The second step was the relocation of Dr. Jennifer Myszewski from Mississippi to the Texas A&M University campus. Dr. Myszewski is a quantitative forest geneticist whose primary assignment will be to continue the SIFG research in this field. Locating her with the WGFTIP staff, however, will facilitate collaboration between the SIFG and the members of the WGFTIP working on problems of common interest. Dr. Myszewski is already familiar with the Cooperative's populations and breeding objectives having completed her PhD at Texas A&M in 2003. This work was directed by Dr. Floyd Bridgwater while he was stationed here under a similar collaborative agreement between the USFS and Texas A&M. For this project, she modeled the impact of selection on negatively correlated traits in small populations such as the Wood Quality Elite breeding program. Her current research emphasizes geographic variation in southern pines and the inheritance of wood quality traits.

Figure 25. Drs. Nurul Faridi and Mohammed Majid of the USDA-Forest Service overlook the supplies to be unpacked for the Forest Tree Molecular Cytogenetics Laboratory.

Forest Tree Molecular Cytogenetics Laboratory[2]

The physical location of rDNA and BAC clones in poplar using fluorescent *in situ* hybridization (FISH) is part of an on going multi-agency NSF Plant Genome Project. Poplar has been considered as a model tree species for forest tree genomics as it has a relatively small genome size (480 Mb / 1C) or about 2.5% of the size of the pine genome. The poplar genome has recently been sequenced using the shot-gun method and was assembled into 2,447 scaffolds. Currently, there is a need to validate some of the scaffolds produced with shot-gun sequencing by locating major repetitive markers using FISH.

[2] Contributed by Nurul Islam-Faridi (USDA Forest Service, Southern Institute of Forest Genetics, Forest Tree Molecular Cytogenetics Lab, College Station, Texas 77843-2585), Lee Gunter and Gerald A Tuskan (Environmental Sciences Division, Oak Ridge National Laboratory, Bldg. 1062-206 P.O. Box 2008, Oak Ridge, TN 37831-6422), Stephen DiFazio (Department of Biology, West Virginia University, 53 Campus Drive, Morgantown, WV 26506-6057), C. Dana Nelson (USDA Forest Service, Southern Institute of Forest Genetics, Harrison Experimental Forest, 23332 Mississippi 67, Saucier, Mississippi, USA 39574)

Preliminary work using 18S-28S rDNA, 5S rDNA, Arabidopsis telomere probes ((TTTAGGG)n) and six BAC clones (from two different linkage groups, LG I and LG VI) on metaphase poplar chromosomes suggest that FISH is a feasible technique for validating scaffolds. We have found two major 18S-28S rDNA sites (Figure 26, arrows) and one minor 5S rDNA site (Figure 26a, arrowheads) in poplar. The Arabidopsis telomere repeat sequence localizes at the end of each chromosome of poplar as expected, revealing that the poplar telomere sequence is very similar to Arabidopsis. All six BAC clones produced discrete FISH signals on poplar chromosomes demonstrating that BACs 87F21 and 66B19 are located on one arm of LG I (also chromosome 1 as it is clearly the longest chromosome) and BAC 75P22 is located to the opposite arm (Figures 26b and 26d). For LG VI, BACs 78O18 and 93N12 are located distally in the euchromatic regions on a small pairs of chromosomes (possibly chromosome 6) (Figures 26c and 26e). BAC 88A10, on the other hand, is located in intercalary position on the opposite arm of chromosome 6 (Figures 26c and 26e). The poplar BAC contig physical map shows no indication of centromere position, but the present results show that the centromere position is easily delineated with FISH (Figures 26d and e).

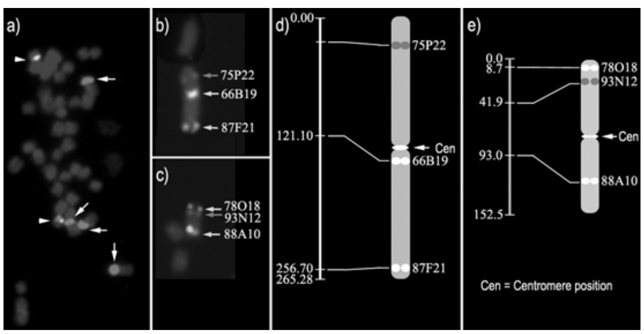

Figure 26. Florescent In Situ Hybridization (FISH) showing locations for rDNA and BACs (bacterial artificial chromosomes) containing poplar DNA sequences located on poplar somatic metaphase chromosome spreads, and diagrammatic representations of cyto-molecular locations of poplar BACs on poplar chromosomes 1 and 6. a) Two 18S-28S rDNA sites (arrows) and one minor 5S rDNA site (arrow heads) in Populus trichocarpa, b) cyto-molecular locations of three LG-I BACs on chromosome 1, c) cyto-molecular locations of three LG-VI BACs on a smaller chromosome (possibly chromosome 6), d) a diagrammatic representation of LG-I BAC-marker positions (on the left) and cyto-molecular locations of three BACs on poplar chromosome 1, and e) a diagrammatic representation of LG-VI BAC-marker positions (on the left) and cyto-molecular locations of three BACs on poplar chromosome 6.

SIFG Research in Quantitative Forest Genetics[3]

In December, Dr. Jennifer Myszewski returned to College Station after two years in Gulfport, MS. Dr. Myszewski worked as a graduate student for the WGFTIP and the USDA Forest Service studying genetic variation in the microfibril angle of loblolly pine and modeling selection for negatively correlated traits in an elite breeding population. She is now a research geneticist with the Southern Institute of Forest Genetics and will be located in the Forest Science Laboratory at Texas A&M University.

Dr. Myszewski continues to study the inheritance of wood quality characteristics and the genetic variability of southern pines as well as other topics. Her research interests include studying the application of infrared and acoustic technology to tree improvement programs, examining the suitability of exotic pines and exotic by native pine hybrids for planting in the southern U.S., and using stochastic simulation to model tree improvement activities. She is also interested in examining geographic variation in lesser-studied species and in the conservation of native tree species. She looks forward to collaborating with the cooperative members on future research projects.

[3] Contributed by Dr. Jennifer Myszewski, USDA Forest Service

Tree Improvement

There was a lull in the Western Gulf Forest Tree Improvement Program – Hardwood effort in 2004/05 as there were no progeny tests measured, no progeny tests planted, and no major orchard establishment efforts. This respite in the usual activities did not, however, represent a break in important program maintenance. Grafting to back-up parental selections in scion banks and to fill in orchard positions continued, the cooperative managed seed orchards for six species, maintained existing progeny tests and several natural regeneration studies. Orchard work included thinning, pruning, and a pesticide injection study conducted by Dr. Don Grosman. One of the most significant activities was the collection of acorns from the second-generation cherrybark oak orchards maintained by the Arkansas Forestry Commission, the Mississippi Forestry Commission and the Texas Forest Service. Seed will be sown in 2006 to begin progeny testing these orchards.

Progeny Testing

The members of the WGFTIP-Hardwood program currently maintain 22 Nuttall oak progeny tests and one advanced-generation progeny test for sycamore and two advanced-generation progeny tests for sweetgum. Progeny tests have been closed as they reached age 20 for most species. Tests for several other species have been dropped at earlier ages if they were deemed to be off site or if they expressed severe disease symptoms. As a result, the number of progeny tests maintained by the cooperative has been steadily declining.

Figure 27. Joe Hernandez, Texas Forest Service, inventories cherrybark oak acorns collected by the Arkansas Forestry Commission and the Mississippi Forestry Commission.

This lull in progeny testing activity should be at an end as many of the seed orchards that were established with selections from open-pollinated progeny tests begin significant seed production. The cooperative has made two failed attempts to collect seed from green ash orchards to begin this process. Because of the lack of success in making family seed collections for this species and the current interest in planting oaks, the cooperative made the decision to shift the emphasis to evaluate the oak orchards. The Arkansas Forestry Commission and the Mississippi Forestry Commission collected seed from 47 of the 60 families represented in the cherrybark oak orchards (Figure 27). Seed has been sown by the Texas Forest Service with the intention of planting progeny tests in the fall of 2006 (Figure 28).

Figure 28. Larry Miller and Joe Hernandez sow some of the 13,000 containers that will be used to grow the progeny test series for the evaluation of the cherrybark oak seed orchards.

Seed Orchards

The primary activities in the hardwood seed orchards in 2005 were directed toward maintaining orchard health and vigor. Several organizations thinned or pruned orchards. Most of the hardwood orchards were not severely impacted by the hurricanes as they were located slightly more inland than the pine orchards or consisted of younger trees with smaller crowns (Figure 29). Hardwood orchards maintained by Temple Inland Forest at their Forest Lake seed orchard complex and the Texas Forest Service's Hudson orchards both suffered some minor damage from Hurricane Rita and required minor clean-up efforts.

Figure 29. The Louisiana Department of Agriculture and Forestry sweetgum seed orchard in December after the September hurricane.

Dr. Don Grosman, Texas Forest Service, repeated a pesticide injection study at the TFS's Hudson orchard in 2005. This study, installed in the cherrybark oak orchard, was a follow-up to a previous test conducted in the live oak orchard in 2004. The objectives were twofold: 1) to evaluate the ability of emamectin benzoate and fipronil to stop seed losses due to feeding by acorn weevils and 2) to determine if a change in the formulation of the emamectin benzoate application would result in less phytotoxicity than observed in a previous live oak trial.

Unfortunately, the first objective was not met because there were too few acorns to allow any meaningful observations to be made on the efficacy of the chemical treatments. The effect of the injection on the trees, however, could be observed. In the previous live oak trial, injection of Denim® (emamectin benzoate) caused narrow strips of the cambium located above the injection sites to die. This damage appeared to be temporary as the adjacent tissue rapidly began growing over the wounds. The manufacturer has since changed the carrier to a less toxic material and no damage to the treated trees was observed in this year's trials.

PERSONNEL

During 2005, Adam Crain resigned from his position as Aide to Specialist and left the Texas Forest Service to pursue other opportunities. Adam was an enthusiastic and hard working employee and we will miss his contribution. The WGFTIP is pleased to welcome Dr. Jennifer Myszewski from the USDA Forest Service Southern Institute of Forest Genetics. Dr. Myszewski will be the second scientist from this group housed at the Forest Science Laboratory with the WGFTIP staff. Her research will continue to support SIFG research priorities, and her presence will facilitate closer cooperation between our two groups. Her research interests include geographic variation of southern pines and the inheritance of wood quality. The Texas Forest Service and WGFTIP staff now includes the following people:

T. D. Byram ………..…………………...WGFTIP Geneticist
L. G. Miller …… …………Assistant WGFTIP Geneticist
E. M. (Fred) Raley …………Assistant WGFTIP Geneticist
P. V. Sowell ………………………….........Staff Assistant
J. G. Hernandez ………..………………Research Specialist
G. R. Lively ……..……………………Research Specialist
I. N. Brown ……………………………Research Specialist
D. M. Travis, Jr. ……………………….Research Specialist
G. F. Fountain ………...…………………Aide to Specialist
Vacant …………………………………...Aide to Specialist

PUBLICATIONS

Bridgwater, F. E., T. Kubisiak, T. D. Byram, and S. E. McKeand. 2005. Risk management with current deployment strategies for genetically improved loblolly and slash pines. Southern Journal of Applied Forestry. 29(2): 80-87.

Byram, T. D., T.J. Mullin, T. L. White, and J.P. van Buijtenen. 2005. Tree Improvement: Alternative visions for the next Decade. Southern Journal of Applied Forestry 29(2): 88-95.

Byram, T.D., J.H. Myszewski, D.P. Gwaze and W.J. Lowe. 2005. Improving wood quality in the Western Gulf Forest Tree Improvement Program: The problem of multiple breeding objectives. Tree Genetics and Genomes 1(3): 1-8.

McKeand, S. E., E. J. Jokela, D. A. Huber, T. D. Byram, H. L. Allen, B. Li, T. J. Mullin. Performance of improved genotypes of loblolly pine across different soils, climates and silvicultural inputs. Forest Ecology and Management. In Press.

van Buijtenen, J. P. and T. D. Byram. Southern pine breeding and genetic resources. In: Burley, J., J. Evans, and J. Youngquist Eds. The Encyclopedia of Forestry. Academic Press. Elsevier, LTD. Publishers pp. 1521-1527.

van Buijtenen, J. P. and T. D. Byram. A random walk through the history of breeding for wood quality. 28th Southern Tree Improvement Conference. In press.

White, T. L. and T. D. Byram. 2004. Slash pine tree improvement. In: E.D. Dickens, J.P. Barnett, W.G. Hubbard and E.J. Jokela Eds. Slash Pine Symposium General Technical Report-2003. Gen. Tech. Rep. SRS-76. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. pp. 7-19.

COOPERATIVE TREE IMPROVEMENT PROGRAM MEMBERS

Western Gulf Forest Tree Improvement Program Memberships

Pine Program

Full members of the Western Gulf Forest Tree Improvement Pine Program in 2005 include the Arkansas Forestry Commission, CellFor, Inc., Deltic Timber Corporation, ETT, L.P. (represented by Molpus Timberlands Management), Forest Capital Partners, International Paper Company, Louisiana Department of Agriculture and Forestry, Mississippi Forestry Commission, Oklahoma Department of Agriculture, Food and Forestry, Plum Creek Timber Company, Potlatch Corporation, Temple-Inland Forest, Texas Forest Service, Weyerhaeuser Company. ArborGen joined the WGFTIP as a Sustaining Member.

Associate members include International Forest Seed Company, Louisiana Forest Seed Company, and Robbins Association.

Hardwood Program

The WGFTIP Hardwood Program includes the Arkansas Forestry Commission, Louisiana Department of Agriculture and Forestry, Louisiana Forest Seed Company, Mississippi Forestry Commission, Potlatch Corporation, Temple-Inland Forest, and the Texas Forest Service.

Urban Tree Improvement Program

The Urban Tree Improvement Program has received past support from the following municipalities and nurseries: Aldridge Nurseries (Von Ormy), Altex Nurseries (Alvin), Baytown, Burleson, Carrollton, Dallas, Dallas Nurseries (Lewisville), Fort Worth, Garland, Houston, LMS Landscape (Dallas), Plano, Rennerwood (Tennessee Colony), Richardson, Robertson's Tree Farm (Whitehouse), and Superior Tree Foliage (Tomball).

Financial Support

Financial support was provided by members of the Western Gulf Forest Tree Improvement Program, the members of the Urban Tree Improvement Program, the Texas Agricultural Experiment Station, the Texas Forest Service, the Texas Christmas Tree Growers Association, and the USDA Forest Service.