Growing Stock: Genetics and Seedlings

Delivering Genetic Gain and Economic Value to Landowners in Southern US

Steve McKeand, J.B. Jett, Trevor Walker, Austin Heine, Tori Brooks, April Meeks, Eddie Lauer, Ross Whetten, and Fikret Isik
NC State University Cooperative Tree Improvement Program

SESAF 2018 Annual Meeting
“Trees: Growing...Selling...Using”
The Lodge and Spa at Callaway Gardens, Pine Mountain, Georgia

January 29, 2018

More Options for Landowners and Foresters than Ever Before

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Thanks and Acknowledgements

Thank You to the Best TIP Staff Anywhere!

Thank you to the Cooperative members who make the program work on the ground
Thanks and Acknowledgements

Southeastern Society of American Foresters

SES AF 2018 Annual Meeting
"Trees: Growing…Selling…Using"

Tree improvement coupled with good silviculture = big increase in productivity

Source: Fox et al. 2007. J. Forestry

“Trees: Growing…Selling…Using”

Tree Improvement is Big Business in the Southern US
• Tree Improvement is Critical to the Success of Plantation Forestry
• Members of the NC State University Cooperative Tree Improvement Program have provided the genetic material that has been planted on approximately 750,000 to 850,000 acres per year (1+ million acres in recent past)

Genetic Improvement of Loblolly Pine

Steve McKeand, NCSU Cooperative Tree Improvement Program

SES AF Presentation, Callaway Gardens, GA, Jan. 29, 2018
Conceptually, tree improvement is straightforward

Look for good trees
  Select them
  Bring them together to inter-mate
  Test their progeny
  Select the winners
  Start cycle over

Conceptually, tree improvement is straightforward

Look for good trees
  Select them

Over 4000 trees were selected to start our breeding program
Huge genetic base assures that long-term gains can be made and risk minimized

Conceptually, tree improvement is straightforward

Look for good trees
  Select them

Bring them together to inter-mate
Bring them together to inter-mate
How do we do that?
Delivery of Genetic Gain

- Seed orchards are the primary delivery system for genetic gain and value
- A typical loblolly pine seed orchard would have 15-20 selections grafted at wide spacing (30’x30’ to 45’ x 45’) managed to produce seed as quickly as possible

Conceptually, tree improvement is straightforward

Look for good trees
Select them
Bring them together to inter-mate
Test their progeny

Conceptually, tree improvement is straightforward

Look for good trees
Select them
Bring them together to inter-mate
Test their progeny
Test progeny of selections to pick out winners and throw away losers

Conceptually, tree improvement is straightforward

Look for good trees
Select them
Bring them together to inter-mate
Test their progeny
Select the winners

1-year old Progeny Test

6-year old Progeny Test
Conceptually, tree improvement is straightforward

Look for good trees
Select them
Bring them together to inter-mate
Test their progeny
Select the winners
Start cycle over

4th-Cycle Selections & Breeding

5th-Cycle selection will start next year!

So What Has This Gotten Us?

Regeneration Options for Landowners
Landowners have never had so many options to plant loblolly pine of outstanding genetic quality
Regeneration Options for Landowners

- Landowners and foresters need to know when and when not to invest in the best genetics
- Understanding the benefits and costs of specific families allows foresters to optimize land management decisions

Tree Improvement is Big Business in the Southern US

- Plantation establishment is very different than in most of the US
- 95+% of all loblolly pine plantations are established with individual families
  - 80% open-pollinated families*
  - 15% full-sib families
  - 2% clones
  - 3% mixtures

*Steve’s guestimates for 2017 based on 2013 survey of all members of the southern TI Cooperatives

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Much more emphasis on genetic gain

Regeneration Options for Landowners

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*Steve’s guestimates for 2017 based on 2013 survey of all members of the southern TI Cooperatives
Delivery of Genetic Gain

- **Seed orchards** are the primary delivery system for genetic gain and value

In the old days, it was easy

Cones were mixed, and everything was the same

Today... many more options
Over 800,000,000 open-pollinated loblolly pine seedlings are grown annually in the South - From average to excellent genetic quality

3rd-cycle orchards
Currently ~ 60% of seed harvests

4th-Cycle Orchards Coming Soon

Mass Production of Control Crosses
Over 1.4 million bags were pollinated in spring 2016
1.4 million again in 2017

About 15% of all loblolly pine seedlings planted in 2017

Has become operational – similar to production of hybrid corn
Produce millions of seedlings of specific crosses
680+ million since 2000
Much greater gains
How good are full-sibs vs. OP

• When both the open-pollinated and full-sib families are compared together, 95 of the top 100 families for volume are full-sibs.
• This is to be expected since tree improvement foresters only make production crosses among the very best parent trees, and the inferior pollen found in OP families is eliminated.

How good are full-sibs vs. OP

• The best full-sib families also have much better stem form and better fusiform rust resistance than the best OP families.
• Stem straightness: 503 full-sib families rank higher than the best OP family.
• Rust resistance: 293 full-sib families are superior to the best OP family
• Stem forking: 194 full-sib families rank better than the best OP family.

A True Seedling Market has Emerged

• Any landowner can now purchase any loblolly pine family
• This has been a dramatic change over the last 10 years
• When the large vertically integrated forest products companies controlled much of the production of improved seedlings, the best genotypes typically went to their own lands.

A True Seedling Market has Emerged

• Companies had long-term investments in developing the genetic resource and recognized the value of genetics for increasing productivity and value of their plantations.
  – They wanted to benefit from growing and harvesting the highest value trees on their own land.
• The best genetics were not typically available to other landowners.
Now, everything is for sale

Nursery vendors who are members of the NCSU Cooperative Tree Improvement Program

- ArborGen, Inc. [http://supertreeseedlings.com](http://supertreeseedlings.com)
- Blanton’s Longleaf Container Nursery
- GA Forestry Com. [http://www.gfc.state.ga.us/seedlings/seedlingprices.cfm](http://www.gfc.state.ga.us/seedlings/seedlingprices.cfm)
- NC Forest Service [http://store.yahoo.net/nc-forestry/pineseedlings.html](http://store.yahoo.net/nc-forestry/pineseedlings.html)
- South Carolina Forestry Com. [http://www.state.sc.us/forest/nur.htm](http://www.state.sc.us/forest/nur.htm)
- White City Nursery [https://sites.google.com/summithelicopters.com/whitecitynursery](https://sites.google.com/summithelicopters.com/whitecitynursery)

Regeneration Options for Landowners
Landowners have never had so many options to plant loblolly pine of outstanding genetic quality

Regeneration Options

SOM  
OP  
MCP / CMP  
SE

It is confusing!!! 
But, it’s well worth understanding!
Would you prefer to sell this?

Or this?

So what’s all this worth?

Oct/Nov 2006
Journal of Forestry 104:352-358

What Are the Best Loblolly Pine Genotypes Worth to Landowners?

Stevens E. McKeand, Robert C. Aber, H. Lee Allen, Braden L., and Glenn P. Cahn

Tree improvement has been a standard silvicultural tool in southern pine improvement programs in the Southeast for 60 years. Virtually all of the almost 1 billion loblolly pine seedlings planted across the Southeast have been selected through single-tree ranking and planting or breeding programs. Loblolly pine seedlings provide the highest quality of seed for the loblolly pine species. Selection of the best seed sources and planting stock are necessary to ensure a well-developed stand of trees with high yield potential. This selection process continues today.

American Forests has used a variety of techniques to improve seed sources, including seed source analysis, genetic analysis, and seedling selection. These techniques have been successful in improving the quality of seedlings and ensuring the survival of trees.

Is it a good idea to plant trees with the best genotype? This question is often asked by landowners and managers. The answer depends on the specific location and management objectives. However, planting trees with the best genotype can improve the overall performance of the stand and increase the value of the forest. Therefore, it is important to consider the best genotype when selecting trees to plant. The information presented in this article can help landowners and managers make informed decisions about planting trees with the best genotype.
So what’s all this worth?

We estimate that landowners can realize net present values of $50 to over $300/ac across a range of productivity and silvicultural management regimes simply by planting the best genotypes that are currently available from commercial and state forest nurseries.

How do we convey this range in value to customers and landowners?

Marketing Our Product

- Educating foresters and landowners about the value of tree improvement
- Development of Performance Rating System

PRS™
Loblolly Pine Performance Rating System

**PRS™**

- The Cooperative the Loblolly Pine Performance Rating System (**PRS™**) as a service to landowners, nursery managers, the tree improvement community, and loblolly pine breeders.
- The **PRS™** expresses the **genetic potential** of a family.
Loblolly Pine PRS™ - description

Progeny test results of measurements at age 6 years are listed in the box to the right.

Volume Rating and Height Rating are predicted progeny performance of open-pollinated (OP) families expressed as percentage deviations from the combined average of local non-improved loblolly pine checktrees across the Atlantic and Lower Gulf/New Coastal Plains (e.g., CCC). Family N-942 is predicted to be 20% taller and have 63% more stem volume at age 6 years compared to non-improved check trees.

R-50% of Z indicates that this family is expected to have 75% of the trees infected with fusiform rust galls in a site where non-improved loblolly pine would have 50% rust infection.

Straight % score of 44 indicates that this family is expected to have 44% straighter stems compared to the non-improved check trees.

Forking (F-50%) of 36 indicates that this family is expected to have 36% of the trees with forked stems or major ramiform branches at a site where non-improved loblolly pine would have 50% forked stems or ramiform branches.

Adaptability Risk for N-942

The minimum winter temperature "origin" of Family N-942 is 16.7°F (6°C line). Planting in the green shaded areas on the map up to 5°F colder (south of -5°F line) has minimal risk of cold damage. Planting in areas that are 5-10°F colder than the origin (between -5°F and -10°F lines) will increase the risk of cold damage. Areas that are more than 10°F colder than the origin are too cold and planting is not advised (north of -10°F line).

Family N-942 has been tested by members of the NC State University Cooperative Tree Improvement Program.

Adaptability Risk for SC Piedmont family

The minimum winter temperature "origin" of Family Piedmont SC Family is 11.95°F (0°C line). Planting in the green shaded areas on the map up to 5°F colder (south of -5°F line) has minimal risk of cold damage. Planting in areas that are 5-10°F colder than the origin (between -5°F and -10°F lines) will increase the risk of cold damage. Areas that are more than 10°F colder than the origin are too cold and planting is not advised (north of -10°F line).

Family Piedmont SC Family has been tested by members of the NC State University Cooperative Tree Improvement Program.

Adaptability Risk for Florida family

The minimum winter temperature "origin" of Family FL Loblolly is 20.8°F (0°C line). Planting in the green shaded areas on the map up to 5°F colder (south of -5°F line) has minimal risk of cold damage. Planting in areas that are 5-10°F colder than the origin (between -5°F and -10°F lines) will increase the risk of cold damage. Areas that are more than 10°F colder than the origin are too cold and planting is not advised (north of -10°F line).

Family FL Loblolly has been tested by members of the NC State University Cooperative Tree Improvement Program.
Genetics is conveniently packaged as seedlings in a bag that cost from 5 to 35 cents each.

**Loblolly Pine PRS™**

**Performance Rating System**

Full-sib Family Code: **SuperCross**

- **PRS™** Ratings — Predicted Family Performance
  - Productivity Rating: 79
  - Rust Resistance Grade: A+
  - Stem Form Grade: A+

The **PRS™** ratings indicate that the progeny of family is projected to be:

- **P** = 79 → Approximately 79% greater stem volume at age 6 compared to the combined average of local non-improved loblolly pine checklots across the **Atlantic and Lower Gulf Coastal Plains**.
- **R** = A+ → Superior for resistance to fusiform rust disease
- **S** = A+ → Superior for stem straightness

**PRS™**

- **PRS™** is licensed to members of the NCSU Cooperative Tree Improvement Program
- Landowners should work with our consulting company members and nursery vendors to make sure you get the *appropriate* genetics to meet your objectives
- If your consultant is not a member of the Cooperative, he/she should be!
Cooperative Tree Improvement Program

9 Full Members
- ArborGen, Inc.
- Georgia Forestry Commission
- Hancock Timber Resources Group
- International Forest Company
- North Carolina Forest Service
- Rayonier, Incorporated
- Virginia Department of Forestry
- The Westervelt Company, Inc.
- Weyerhaeuser Company

6 Research Members
- Arauco - Bioforest, S.A.
- GenoVerde Biosciences, Inc
- J.D. Irving, Limited
- New Brunswick Tree Improvement Council
- PBS International
- USDA Forest Service

23 Contributing Members
- American Forest Management
- Blanton’s Longleaf Container Nursery
- Campbell Global
- Charles Ingram Lumber Co.
- Dougherty & Dougherty Forestry Service, Inc.
- F&W Forestry Services, Inc.
- Forest Investment Associates, LLC
- Four Rivers Land & Timber Company, LLC
- GFR Forestry Consultants
- GreenWood Resources
- Jordan Lumber & Supply Company
- Larson and McGowin, Inc.
- Meeks Farms & Nursery, Inc.
- Milliken Forestry Company
- Molpus Woodlands Group, LLC
- ProFOR Consulting
- Resource Management Service, LLC
- Roseburg Resources Co.
- Scotch Land Management, LLC
- South Carolina Forestry Commission
- Timberland Investment Resources, LLC
- White City Nursery, LLC
- Z.V. Pate, Inc.

Regeneration Options for Landowners

Landowners have never had so many options to plant loblolly pine of outstanding genetic quality.

A true seedling market has evolved
More of a revolution than evolution
Everything is for sale!

If your consultant is not a member of the Cooperative(s), he/she should be!
Forestry 101 – what are your objectives?
Without a thorough understanding the genetics you are planting, you are failing FOR 101!
How much rust resistance is needed?
What is stem quality or wood quality?
How do you project stand value?

How do you project stand value?
The only way to do this is to know exactly what you plant
Not all OP families or FS families or clones are alike
**PRS™**

- How do you project stand value?
- The only way to do this is to know exactly what you plant
- Not all OP families or FS families or clones are alike

**Invest the seedlings that will meet your management objectives!**

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**Thank You!**

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