Improved Returns on Forestlands:

A Financial Analysis of MCP and Varietal Seedlings on Private Land in the Southeastern United States

—Derek Dougherty

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Only recently have seedlings with the genetic quality of mass control pollinated (MCP) and varietal material been available for non-industrial private forest landowners. MCP planting stock consists of seedlings produced by the application of pollen collected from the best father tree to the flowers of the best mother tree. This approach produces the very best growth, stem form, and disease resistance possible from loblolly pine orchards. Varietal planting stock derives from selection of the best individual from the "best MCP parent cross" and replication of this individual. The use of varietal planting stock means that every planting spot is planted with a seedling that has the highest genetic gain possible.

On November 2, 2006, MeadWestvaco gave a group of forest landowners and managers an exclusive tour of its Charleston, South Carolina loblolly pine plantations established with some of the most advanced genetically-improved planting stock (the tour was additionally hosted by Forest Landowners Association, ArborGen LLC, and Dougherty & Dougherty Forestry Services, Inc.). The opportunity to see experimental forest stands ranging in age from 2 to 13 years that were derived from this advanced genetic material was a real eye-opener! Seeing stands that are projected to attain heights of 93 to 105 feet by age 25, versus standard plantations capable of heights of 65 to 75 feet at the same age certainly necessitates a re-evaluation of the potential returns possible from forestlands in the southeastern United States.

The increased returns from using enhanced genetic seedlings can help to offset the higher cost of forestland today and can help landowners in the southeast remain competitive global wood suppliers. Two of the primary factors that determine returns from pine plantations are the genetic quality of the seedlings planted and the silvicultural treatments used to channel site resources

Product	Stumpage Price	Product Specifications
Pine Sawtimber:	$45/ton	13.0" dbh o.b. to 8" top dib
Pine Pulpwood:	$8/ton	4.0" dbh o.b. to 2" top dib
Pine Chip-n-saw:	$22/ton	9.0" dbh o.b. to 6" top dib

Genetic Option	$/Seedling	$/M
Bareroot OP	$.05	$50
Bareroot MCP	$.11	$110
Bareroot Varietal	$.40	$400
Containerized OP	$.11	$110
Containerized MCP	$.15	$150
Containerized Clone	$.50	$500

Estimates include treatment and shipping

Activity	Cost
Handplanting Labor	$45/acre
Chemical Site Preparation	$105/acre
Chemical Site Preparation—Wide Row Spacing	$65/acre
Mechanical Shear	$140/acre
Mechanical Shear—Wide Row Spacing	$100/acre
Mechanical Bed	$90/acre
Mechanical Bed—Wide Row Spacing	$60/acre
Herbaceous Weed Control Band	$40/acre
Herbaceous Weed Control Broadcast	$60/acre
Herbaceous Weed Control Directed Spot	$50/acre
Herbaceous Weed Control Directed Total Acre	$100/acre
Herbaceous Weed Control Banded Wide Row	$30/acre
Fertilization—Heavy Dose	$120/acre
Fertilization—Lighter Dose	$100/acre
Machine Planting Labor	$70/acre

Evaluation Methods, Carrying Costs, and Assumptions

- Net Present Value
- 7% Discount Rate
- Land Cost of $1,000/acre
- "Real", Non-inflated Stumpage Values and Management Costs
- Annual Taxes Assumed Offset by Hunt Club Leases

Figure 1: Prices, costs, and discount rate assigned for financial evaluation of MCP and varietal seedlings

to the planted seedlings. For this article, Dougherty & Dougherty Forestry Services, Inc. conducted an independent analysis (using the assumptions and choices in Figure 1) that compares the benefits that can be attained by varying genetic quality of seedlings used to regenerate loblolly pine stands in the southeastern United States, such as tour participants saw on MeadWestvaco's plantations in Charleston. See the accompanying article on page 26 that focuses on the silviculture necessary for enhanced genetic seedlings to express their growth potential.

Figure 1 provides a list of assumptions and choices regarding costs, stumpage prices, and economic variables that allow for the comparisons of the potential impacts of deploying enhanced genetics on future stand value. (Because markets vary considerably, forest landowners and forest management professionals should make their own assumptions and choices for making their personal or corporate evaluations, and should make estimates of future yields, as well.). In this particular analysis, growth and yield (G&Y) projections were provided by MeadWestvaco, whose G&Y model is developed for the area in which the tour was conducted and has been validated for high yielding stands. The predicted yields correlated well with the volumes actually observed in the toured stands.

Increased Site Productivity: Genetic Versus Silvicultural Contributions

Most landowners, without detailed studies, cannot separate the results obtained from silvicultural techniques from the gains obtained from planting enhanced genetic planting stock. What they see standing in the forest is the tree's phenotype, which is the exhibited growth resulting from the tree's genotype and its interaction with its environment; thus it is hard to isolate the direct genotype results. However, we can say with certainty that if landowners increase productivity, either through enhanced genetics, improved silviculture, or a combination of the two, they increase potential value of stands as demonstrated in Figure 2.

For demonstration purposes, we projected stand values for a standard regime at three site productivity levels, including site index (SI) 75 feet (growth potential to produce dominant and co-dominant trees that are 75 feet at age 25), SI 85 feet, and SI 95 feet. The standard regime we used for this analysis included intensive site preparation, planting of 435 trees per acre, herbaceous weed control treatment, thinning to the best 200 trees per acre when the dominant/co-dominant pines reached 45 feet, and clear-cutting at age 23. The resulting volumes removed at the final harvest were 132 tons, 183 tons, and 244 tons for the increasing productivity levels. An increase in site index of 20 feet increased final harvest volume significantly: by 85 percent. The major increase in value comes from pushing a larger portion of the trees into the higher valued product classes as noted in Figure 3. Estimated final harvest values for the increasing productivity levels were as follows: $3,356, $5,801, and $9,115. Thus, in this example, an increase in site productivity of 20 feet created a potential gross harvest value increase of 172 percent.

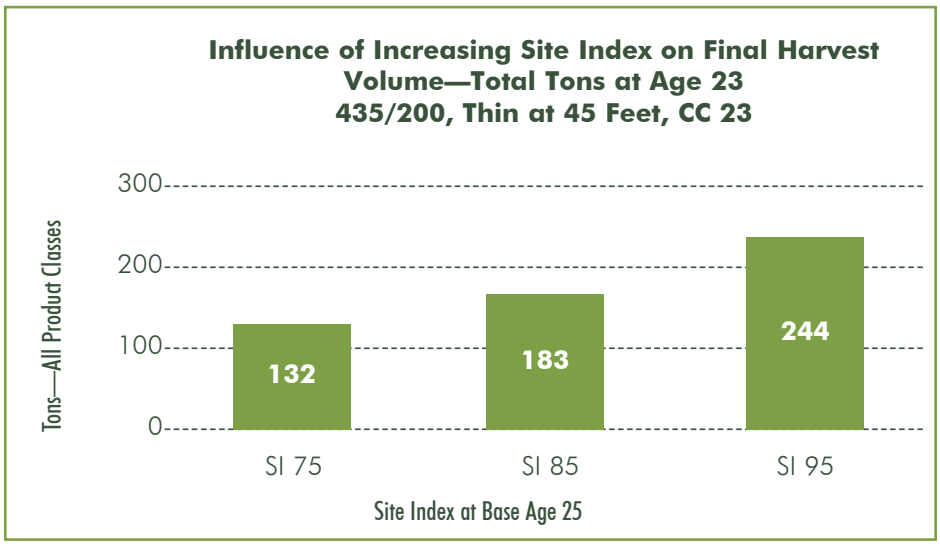

Figure 2: Increases in productivity can be obtained through either increased genetics or improved silviculture. For the standard evaluation regime, an increase of 20 feet in exhibited site index increased final harvest volume by 112 tons/acre in a 23-year rotation.

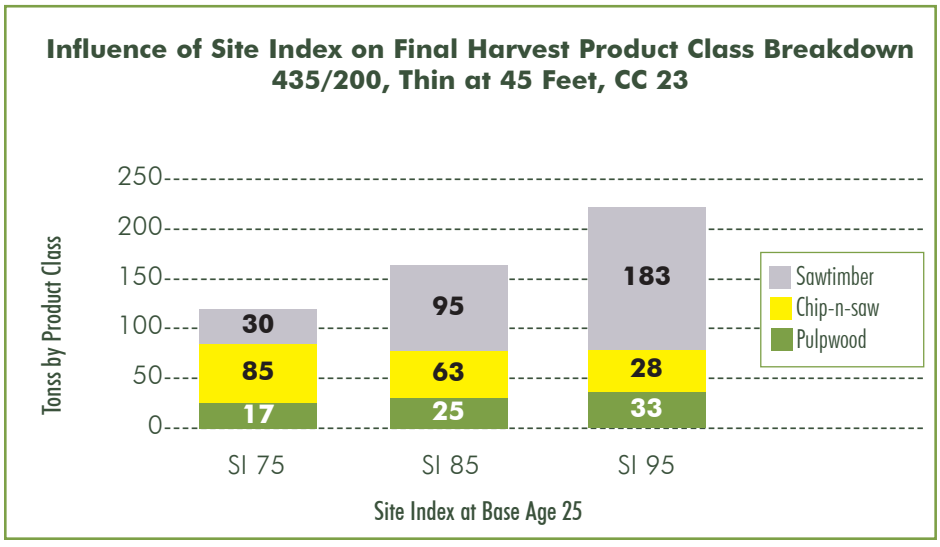

Figure 3: Assuming 100% grade (all trees meeting diameter requirements are sufficient in quality to make the higher valued product class), increasing productivity from an exhibited SI 75 to SI 95 at base age 25, increased sawtimber production from 30 tons/acre to 183 tons/acre at final harvest at age 23.

The Isolated Effect of Percent Grade/Crop Trees

Not many people have seen loblolly pine plantations worth $9,115/acre at age 23, primarily because few managers have reached this level of productivity, but also because the product allocations (breakdowns between pulpwood, chip-n-saw, and sawtimber) predicted in the models do not always meet what we see in the real world, because the percent grade (the percent "crop" trees), or the inherent percent of trees in a plantation that will make sawtimber or higher product classes in a reasonable time, are limited in traditional open-pollinated stands.

In most existing plantations on non-industrial private forest (NIPF) land, only 25 to 50 percent of the trees in the original planted population, prior to the first operator-select thinning, will show the potential to make multi-log trees in the sawtimber product class. The remaining 50 to 75 percent are forked, crooked, suppressed, or diseased. After one typical operator-select thinning in these stands on NIPF lands, there are still often only 50 to 60 percent of the residual trees that are capable of making the higher product classes. While there is certainly wide variability in quality percentages for open-pollinated seedlings, we used 55 percent in this analysis as a residual, post-thin percentage for operator-select plantations. In comparison, mass-control pollinated stands, with a known flower and pollen supplier combination, may average 80 percent quality crop tree potential after one operator-select thinning. In theory, varietal plantations, with the best tree and the identical genotype at each planting spot, should have 100 percent crop trees. In this analysis, we used a 95 percent grade trees estimate after thinning, simply to acknowledge that environmental factors, not only genetics, can limit actual percent grade trees in a stand.

To isolate the effects of percent grade, we set the productivity or site index at 90 feet, estimates of 55 percent grade for open-pollinated, 80 percent grade for MCP, and 95 percent grade for varietal; we made projections utilizing the same standard management regime as listed above. The results in product allocation are shown in Figure 4. The results in gross harvest value, as shown in Figure 5, were $4,927 for open-pollinated, $6,348 for MCP, and $7,246 for varietal plantations, showing clear potential for value increase from improvements in percent grade alone.

The Combined Effect of Increased Site Productivity and Percent Grade

To reach full potential, landowners need to plant seedling genotypes with high efficiency that also have strong inherent grade potential. If they do this, control competition for water, meet stand nutrient requirements, and control density to focus growth into higher product classes, what is the potential stand value? To evaluate this, we assigned the potential productivity for the three levels of genetic improvement based on actual yield levels; choosing site indices of 87 feet for open pollinated seedlings, 92 feet for mass control pollinated seedlings, and 99 feet for varietal seedlings. The previously chosen percent grades expected for each level of genetic improvement were then applied to the harvest volume predictions to determine product class allocation volumes by genetic level. This

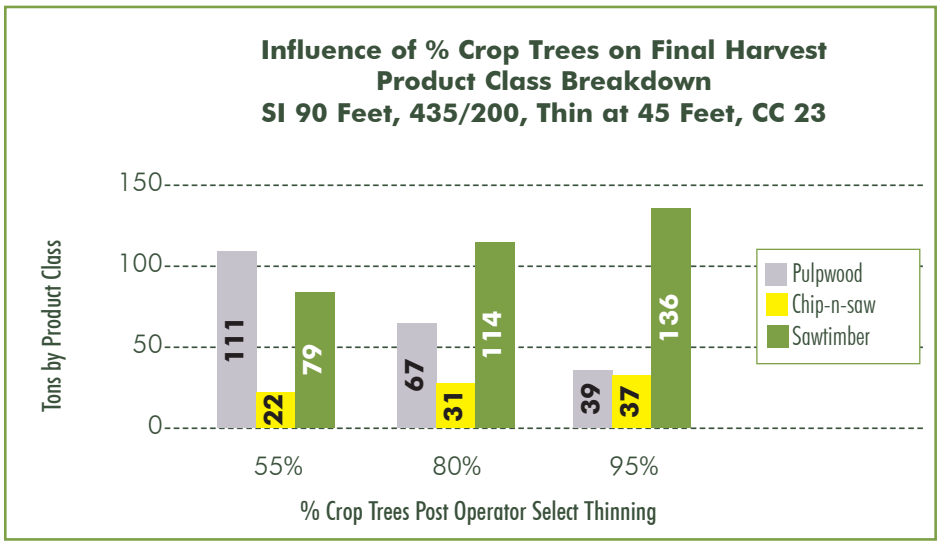

Figure 4: At a fixed level of productivity, the percent of grade or quality potential "crop" trees has a major effect on the production of higher-valued timber.

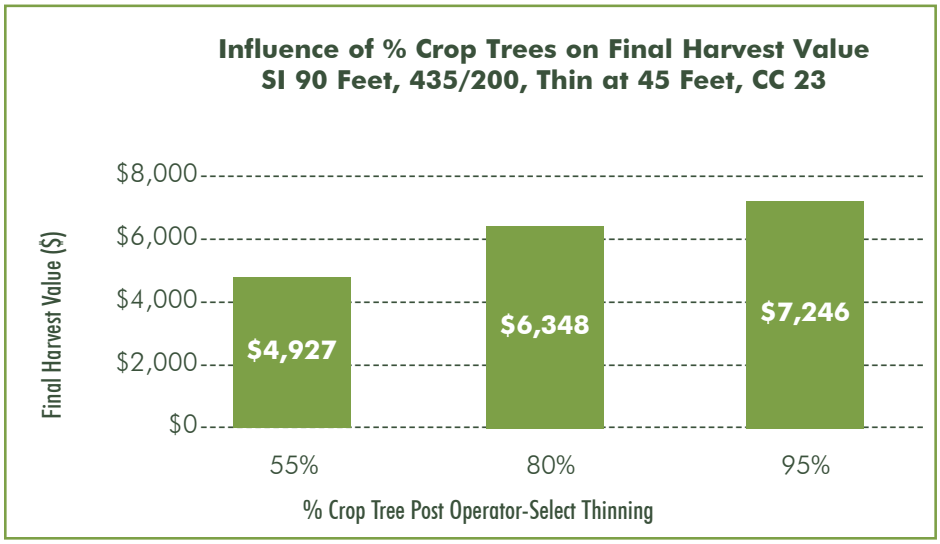

Figure 5: At a fixed level of productivity, increasing the inherent percentage of trees capable of making sawtimber versus just pulpwood from 55% to 95%, increased final harvest value by 47% at age 23. The only way to improve the inherent percentage of quality trees is through improved genetics.

exercise estimates the potential gross harvest value of open-pollinated plantations to be $4,267/acre for the chosen comparative management regime, $6,755 per acre for mass-control-pollinated seedlings, and $10,036 per acre for varietal plantations, under the provided assumptions. In this example, the MCP plantation was capable of producing 58 percent more value, and the varietal plantation was capable of producing 135 percent more value in the same time period as compared to the open-pollinated plantation.

Are They Worth the Added Costs?

With improved productivity and improved grade, it is not a surprise that the evaluations show greater potential for each improved level of genetic material. In our history of tree improvement, while there have been specific elite families of an earlier generation of improvement that have still outperformed families or mixes of advance levels of improvement, we have consistently seen significant improvements with each generation or half-generation of tree improvement. Previously, however, the consumer or small tree farmer has not had to pay a large margin for the next level of improvement. In contrast, the cost of production for mass control pollinated seedlings and varietal seedlings is two to ten times the cost of conventional open-pollinated seedlings; thus, the question is well worth addressing.

To answer the question of the worth of varietal seedlings, we computed and ranked out the best net present values (NPVs) of a range of regimes with varying levels of genetic improvement, varying levels of density, and varying levels of management intensity (including some creative, non-conventional regimes) in Figure 6 (for the sake of space, only the comparative NPV results of the standard regime are in the graph). With a discount rate of 7 percent (real stumpage prices and costs), Figure 6 shows a calculated NPV for the open-pollinated seedlings at –$109, for the MCP at $403, and for the varietal pine plantation option at $998 per acre.

[I]f [landowners] dedicate themselves to improving their forest management and tailor it to favor the specific varieties used, they can make great strides quickly.

In summary, in this example of operating on land worth $1,000 per acre at an intensive level of management, the open-pollinated plantation management failed to meet the defining 7 percent rate of return. In contrast, the MCP plantation produced a rate substantially greater than 7 percent. Despite the much higher per seedling cost, the varietal plantations showed potential for the highest return rates, overcoming the added cost with improved productivity potential and the highest percent grade.

Does this mean that a landowner can simply purchase and plant MCP or varietal seedlings and produce from $7,000 to $10,000 per acre *with ease?* Not a chance. However, if they dedicate themselves to improving their forest management and tailor it to favor the specific varieties used, they can make great strides quickly. The tour of MeadWestvaco's advanced genetic stands clearly indicated that with the use of improved genetic stock and good silviculture, private landowners have the opportunity to close the large gap between current stand values from private forestland and those that can be achieved with the use of the more advanced genetic material that is now on the market.

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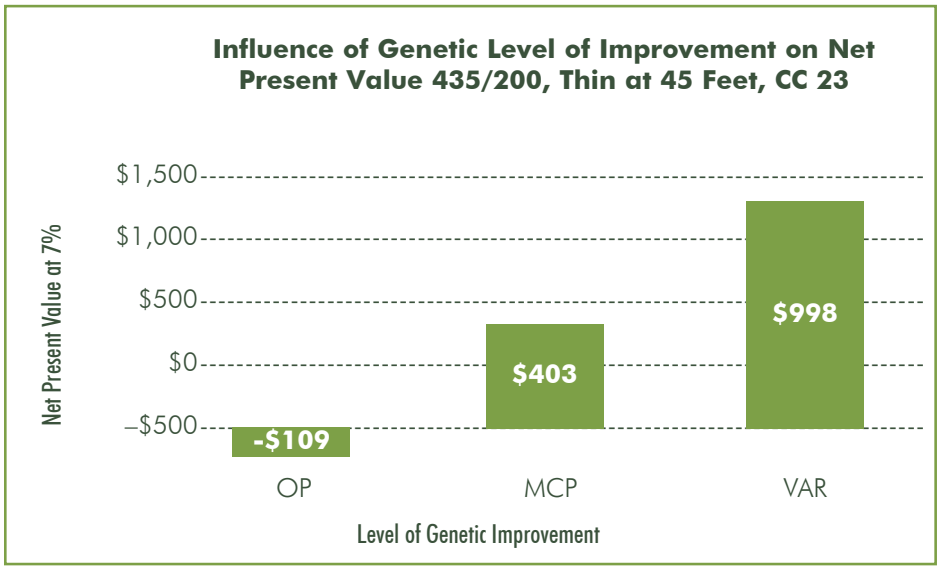
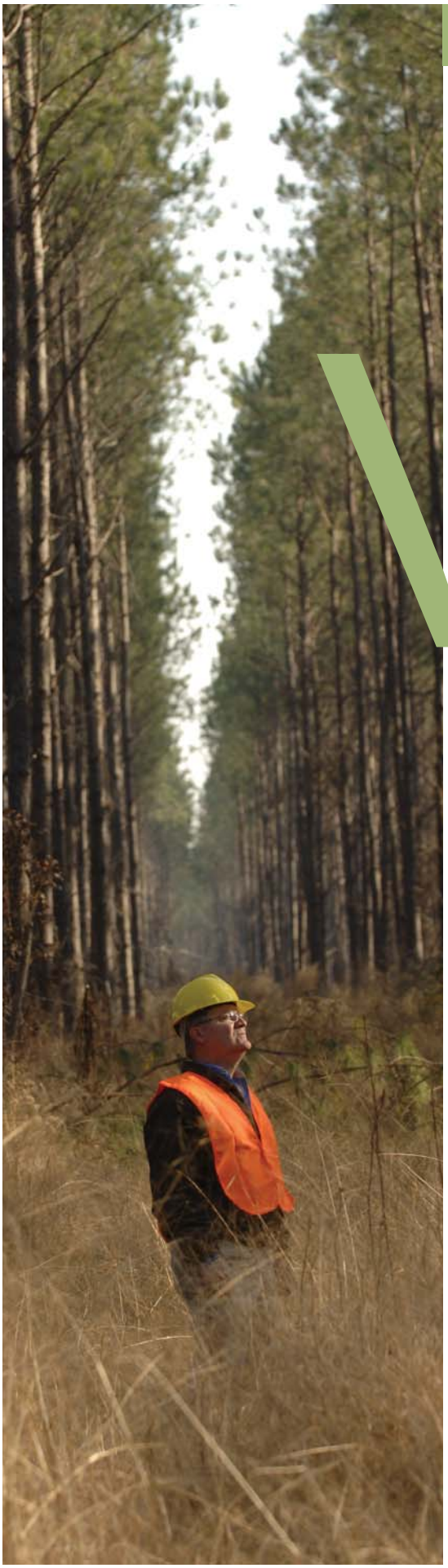


Figure 6: MCP and Varietal seedlings cost more than conventional open pollinated seedlings. Are they worth it or simply put, does the added value justify the added cost? With increasing net present values for each level of genetic improvement, the results of this analysis suggest that they are well worth it at the assigned levels of productivity. The limitation now becomes the level of productivity which is heavily impacted by management quality.



Silviculture for Your Varietal Loblolly Pine Plantation

—Jeff Wright and Derek Dougherty

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Varietal pine seedling availability is rapidly increasing and will continue to capture a larger share of the traditional open-pollinated seedling market. Varietal seedlings offer greater stand uniformity, increased productivity potential, and a much lower percentage of stem defects. The cost of production for varietal seedlings, through the advanced somatic embryogenesis process, is higher than traditional seedlings. Because both the production potential and cost are increased, purchasers have to give additional consideration to the silvicultural treatments and scheduling necessary to allow these advanced seedlings to attain their full potential.

Initially, forest managers based potential stand volume and value estimates on the soil quality; basically how much timber the soil is capable of producing without management. They soon realized that they could improve site productivity above the inherent productivity levels of the soil through silvicultural activities, such as quality site preparation, weed control, and fertilization.

Now, with varietal seedlings managers gain much greater control over the genetic influence on productivity and stand quality. Previously, with open-pollinated seedlings the mother tree (cone) was known but the father tree (pollen) was unknown. This introduced substantial variability. In contrast, with varietal seedlings, not only are the mother and father trees controlled, but the best of the best offspring is chosen and replicated repeatedly. Thus, when managers establish a varietal plantation, they have the best tree and an identical tree placed at every planting spot. This removes the variability from the genetic side of the production potential equation.

Planting the same variety at each planting spot still leaves substantial variability in individual tree and plantation growth, but now this variability can be attributed and isolated to a combination of soil characteristics, site environment, and silvicultural actions. Given everything a variety needs to grow (water, nutrients, light, carbon, and time), the varietal seedlings will exhibit their full potential under the climactic conditions that exist; thus, managers can determine the potential for a given variety in a defined area. This is important because it allows a comparison of the potential of the variety versus what is actually produced. The difference can be termed "fall-down," with fall-down being the lost growth or value that could be potentially gained or captured if our management can be improved.

For instance, as estimated and summarized in the evaluation exercise in the accompanying article on page 15, the difference in value potential between a forest manager growing varietal loblolly pine plantations and operating at a site index (SI) 75-foot level of productivity (growing 75-foot tall pine plantations in a 25-year period) and a forest manager operating at a SI 95 level of productivity (95-foot tall plantations in a 25-year period) may be a gross harvest value difference of $5,759 per acre. In this evaluation, $5,759 per acre is the reward to be gained perfecting systems of management and providing these trees with all that they need to grow. In this article, we will discuss the silvicultural processes that would decrease factors limiting growth in varietal plantations.

Varietal Selection

While we are talking about varietal forestry, in which each individual tree within a specific variety is identical, realize that there is tremendous variability between the different varieties that are coming on the market. Varieties differ in nutrient use efficiencies, stem form, branch size and angle, internode length, crown characteristics, growth rate, and

stability. This is important from a diversity standpoint and it is a responsibility of the tree improvement community to preserve and actually attempt to broaden the variability. Broadening the varieties available will help in meeting specific tree improvement goals now and better preparation for unforeseen challenges and opportunities in the future.

While a varietal plantation manager has little control over the actual development of these varieties, it is very important to understand the traits and requirement of the variety you select and purchase to optimize its growth potential. For instance, if you purchased Mead-Westvaco Variety ON-10 through Arborgen, which has narrow crown characteristics and small branch characteristics, you might be able to plant 350 seedlings per acre without concerns of large branch production, which lowers wood quality.

Other considerations affecting the variety you select for your property should include the variety's zone of origin versus the location of the land base, the geographical area the variety was tested in, your individual timber management objectives, and varietal availability. Your varietal seedling salesperson should be able to assist you with the details of this decision process.

Initial Planting Density Decisions

Varietal seedlings offer a couple of major advantages regarding initial planting density. For decades, foresters have planted high numbers of seedlings to insure survival and to reach an adequate number of potential crop trees per acre. For instance, to get 200 quality sawtimber trees per acre for final harvest with an open-pollinated seedling mix averaging 30 percent quality trees (no forks, fusiform rust, crook, or suppression) foresters would have needed to plant 667 trees per acre. With survival concerns, the forester might have planted additional trees on top of that, perhaps 700 or more seedlings per acre. In contrast, with a quality varietal selection having potentially 100 percent crop trees (all identical and chosen for form), the number of initial seedlings needed drops significantly. Also, many varietal seedlings are now being produced as containerized stock, improving the chance of survival.

Planting number	Category
500–600 per acre	Landowner's site preparation or herbaceous weed control commitment is minimal
400–500 per acre	Landowner will purchase and plant wider crowned varieties and apply intensive silviculture
350–400 per acre	Landowner will purchase and plant elite, narrow-crowned varieties with small branching characteristics and apply intensive silviculture

Varietals are still of concern regarding environmentally-influenced defects and survival. Opinions regarding initial planting numbers differ greatly. The authors' opinion and recommendations for varietal plantation establishment are above.

Site Preparation for Varietal Plantations

Any inherent site limitations that decrease growth potential must be addressed prior to the establishment of varietal pine plantations, including soil drainage and density problems and existing competing vegetation. If the soils on a landowner's tract or a portion of his or her tract to be planted are in the somewhat-poorly to very-poorly drained classes, these areas should be "bedded," similar to the furrows created in row-crop agriculture, only larger. A single-pass bed may be sufficient for the somewhat poorly to poorly drained areas. However, the very-poorly drainage class areas would benefit from "double bedding."

If the bulk density of soil is such that it will impede root growth, some sort of tillage must be considered. If the soil's bulk density is higher than 1.4 g/cm^3, depending on texture, the soils should be sub-soiled or "ripped". Ripping involves using a dozier or large tractor to pull a deep "shank", generally 18 to 24 inches in length, through the soil of the cut-over or field to be planted. The ripping process will help to decrease soil density, improve porosity, and help insure that a quality planting job will be completed. Some managers choose to use a three-in-one type tillage operation which incorporates subsoiling, tillage, and bedding in one pass.

All tracts have competing vegetation in place. Some competing vegetation is harder to control than others. Imazapyr will control many hardwoods and broadleaf weeds. A major key in quality control is correctly identifying and not missing any of the tougher competitors to insure application of the best tank mix of herbicides at the appropriate time to control them. Some to watch for are waxy-leaf brush, invasive species like bermuda or kudzu, and natural pines. Failure to fully control these species before establishment will result in lessened growth and increased risk to herbicide damage.

Herbaceous Weed Control

Early growth of a varietal plantation is primarily driven by available soil moisture. If a varietal plantation has all the water it needs, it may end up with trees of average heights between 4 to 6 feet at the end of the first growing season. In contrast, left sitting and competing in the weeds, growth will be considerably lessened, generally only 1 to 2.5 feet tall at the end of the first growing season. Water deficits can develop even without weed competition, but they can become severe, even to the point of causing mortality, without weed control. Quality herbaceous weed control is crucial to permitting varieties to express their potential.

Herbaceous weed control treatment success, like chemical site preparation or hardwood release treatments, requires proper herbicide tank mixes and application timing. Prevalent chemicals for weed control include imazapyr, sulfometuron, hexazinone, metsulfuron methyl, and glyphosate. These are applied either in a spot (generally 5 to 6 feet centered on the seedling), a band (often 4 to 5 feet centered along the row), or broadcast (covering the entire area). Treatments will either be applied "over-the-top" or directed (directly to the competition, not in contact with the seedling). Timing is

critical. Most of these chemicals are best applied as pre-emergents, prior to the competition sprouting or becoming too established. Directed treatments require sprouting.

The first treatment of the year will generally be applied in March or early April, but can be even slightly later if there is soil active carryover from the previous year's chemical site preparation treatment. Carryover is common when higher rates of imazapyr or two to three ounces per acre of sulfometuron methyl are added to the site preparation tank mix and the application is made late in the year from September through November. Some managers will choose to complete a follow-up herbaceous weed control treatment in the summer of the first growing season on very fertile sites and on converted agricultural land. This treatment will often be completed between mid-May and early July, when the first chemical herbicide treatment begins to break down, or when the harder, later-sprouting weed seeds begin to sprout in the converted agricultural land.

Fertilization

If landowners have prepared their sites well, chosen a quality variety, and controlled the herbaceous competition to jump-start the plantation, the varietal timber stands will have fully occupied the site resources. Near the time of crown closure or thereafter, nutrients may become limited. The actual timing of nutrient deficits occurring will depend on the inherent nutrient supplying capacity of the site and the demand of the variety. More fertile sites may not be limited as early in the forest rotation. To maximize growth in a varietal plantation, nutrition deficits should be identified and eliminated.

Nutrition deficits can be identified through the completion of foliar nutrient analysis throughout most of the rotation. On a lesser percentage of sites, primarily on poorly drained sites in the lower Coastal Plain areas, growth may be limited very early in the rotation by low phosphorus. These limitations can be identified through soil tests and, in some cases, visually. If the plantation gets off to a strong start, but then growth appears to slow dramatically, the trees show a hesitancy to produce leaf area, and the crowns are not full and do not tend to close, landowners should test for low phosphorus. When concentration levels fall below critical levels for phosphorus, nitrogen, or other important nutrients, fertilizer can be added either by groundmobile or aerial application. Application rates, estimated growth responses, and preferred application timings have been researched in detail by the Forest Nutrition Cooperative, so co-op members can make solid recommendations for you to meet site limitations.

Thinning

Mid-rotation commercial thinning is a common practice in loblolly pine plantations in the southeastern U.S. The purpose of the thinning is to select the best crop trees for sawtimber production, lower the number of tree on each acre, and decrease competition for limited resources of light, water, and nutrients. Because of the limited number of trees in the stand that were inherently capable of producing higher valued product classes, it has often been a struggle to lower density while protecting the quality trees. Varietal plantations will make forest management much easier when it comes to thinning, due to the substantially increased percentage of grade or quality "crop" trees. When thinning a varietal plantation, landowners will be able to focus quality control concerns on the number of residual trees, getting it just right to grow a target size tree, rather than having to leave a lot of extra trees that take away resources, just to make sure that there are enough good trees to make a financial crop.

Landowners will still want to inspect their varietal stands prior to thinning to make quality recommendations. While the inherent crop tree percentage will be very high in the chosen varieties, they can still be affected by the environment. Issues like ice storms, hurricanes, tip moth attacks, or deer predation can cause variability in the stand. Similarly, the forest manager's decision-making skills and contractor quality control can still introduce considerable variability. During a pre-thinning inspection, managers should consider the number of quality trees and make sure that they do what is necessary to protect them if the percent crop trees have been lowered by environmental or silvicultural variability effects.

Conclusion

Research and innovation have given the landowners of working forests new opportunities to utilize today's best technologies, which include varietals and silviculture. The potential for increased volume and value production from varietal plantations is real and substantial. Collectively, the managers of private forestland in the southern U.S. have tried and tested many intensive silvicultural regimes over the last 50 years. Some currently implement these regimes with open-pollinated pine plantations. Others focus on cost control and settle for the combination of inherent soil productivity with some gains simply from second generation genetics and quality hardwood control.

Now, with the substantially stepped-up potential of varietal forestry, there is strong justification for re-evaluating and assessing the methods, intensity, and timing of many of these management activities. Because the total potential has been increased with varietal forestry, the potential marginal rates of return for even the individual management activities are increased as well. Implementation of site-specific and variety-specific management regimes will be needed for landowners to reach the potential of varietal forestry.

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