# Optimal management of loblolly pine considering biofuel markets and low sawtimber prices

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**The management of loblolly pine plantations**

Strong sawtimber markets historically are the driving force in determining a management regime for loblolly pine plantations. However, management regimes have varied over time depending on factors such as regeneration costs, timber product prices and cost of capital. As each of these have changed over time, the financially optimal management regimes for loblolly pine plantations have varied from none to multiple thinnings. Foresters use financial formulas to select a management regime and rotation age (final harvest age) that maximize the financial return to the timberland owner. Historically, sawtimber markets have out-performed pulpwood markets, favoring multiple thinning management regimes and longer rotation ages. But times are changing. At least they appear to be. New markets are emerging, even more are on the near horizon and traditional markets are changing.

Paper is no longer the only product produced from pulpwood. New products such as wood pellets, bio-oil and cellulosic ethanol, to name a few, will soon create another market for pulpwood. In fact, we may start referring to pulpwood as fuelwood at some point in the near future. Depending on your timberland's proximity to one or more of these new manufacturing facilities, pulpwood prices may increase in your local market. Consider also that traditional markets for wood building materials have changed markedly since the great recession and the bursting of the U.S. housing bubble. Sawtimber, a product that typically is harvested at final rotation age, has experienced an approximate 35 percent decline in stumpage prices in Mississippi since 2007. As a result, returns to Mississippi forestland, while still positive, are at historic lows. Thus, the question on the minds of many timberland owners is, should I alter the management of my pine plantation to account for these changing market conditions?

The appropriate management regime for loblolly pine plantations is determined by considering the desired end products. It's basically a choice between higher volumes over the life of the rotation of either sawtimber or pulpwood. And, if maximizing financial returns is the primary objective, product prices will affect the desired end product. At this point, much of the current product market for biofuels has focused on logging residuals (e.g., limbs and tops from cut trees). These are collected after a timber harvesting operation. Logging residuals are a relatively inexpensive fuel stock and its associated revenue has little or no impact on the financially optimal management regime determination. However, in the very near future, biofuels are expected to become cost competitive and production volumes will greatly increase. When that happens, logging residuals will not be a sufficient feed stock in terms of volume. Stumpage prices for feedstock will increase, resulting in prices for feedstocks that are comparable to pulpwood prices. In some locations this may increase pulpwood prices. In either case, pulpwood will be increasingly utilized as a primary biofuel feed stock. Given this potential paradigm shift in wood product utilization, the question for timberland owners and managers is the same. What is the financially optimal management regime and rotation age for loblolly pine plantations? Over the next several paragraphs we will consider some factors that will allow us to answer this question.

A recent research project examined price thresholds (i.e., indifference points) where management regimes for loblolly switch from sawtimber (one and two thinnings) to pulpwood (no thinning) management regimes. The objectives were 1) to determine what end products should be targeted under current prices, 2) to identify how desired products change with site index (i.e., a measure of land productivity for growing trees), planting density, and interest rates, and 3) to identify the relative product prices at which forestland owners are indifferent between sawtimber and pulpwood/fuelwood rotations.

The study considered a host of different factors. Site indices were allowed to range from 50 to 90 feet with a base age of 25. Site index is a measure of a site's productivity. A site index of 50 base age 25 means that a site could grow trees to a height of 50 feet in 25 years. Two planting densities were also considered. These were 681 (8' x 8' spacing) and 538 (9' x 9' spacing) trees per acre assuming 80 percent survival after year one. Discount rates or minimum acceptable rates of return (MAR) were allowed to range from 6 to 12 percent. Two primary timber products were considered: sawtimber with an eight-inch small end diameter and pulpwood with a four-inch small end diameter. Per ton product prices were evaluated at relative rather than absolute prices. This approach allows the study results to be compared to product prices at any point in time as the relative price approach express one product as a percentage of the other (i.e., pulpwood as a percentage of sawtimber prices). *(See Figure 1)*.

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**FIGURE 1**

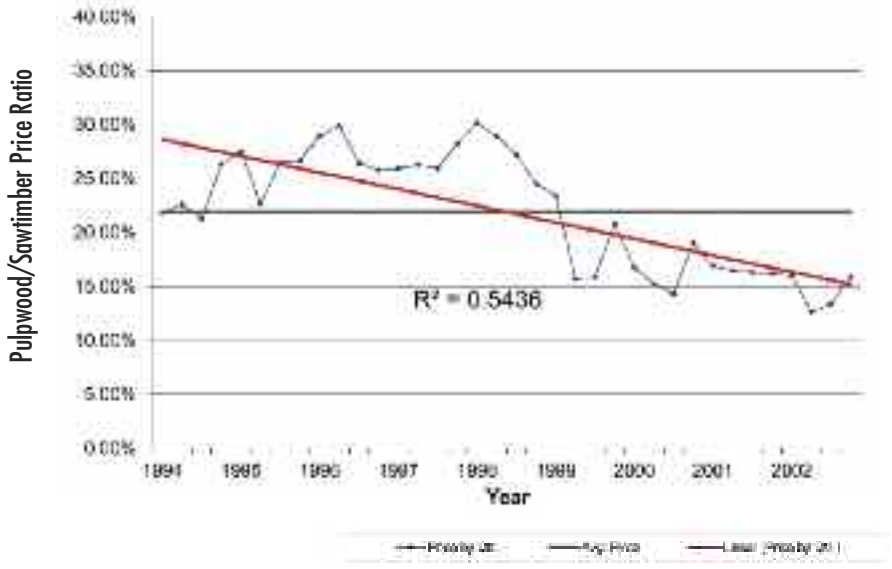


Figure 1. Range of Mississippi stumpage prices for sawtimber and pulpwood from 1994 - 2002 indicating the pulpwood price as a percentage of sawtimber price.

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Per acre establishment costs, which were normalized by sawtimber prices, were assumed to include the following: chemical site preparation at $66.23 per acre, site preparation burning at $15.50 per acre, and planting at $0.69 per seedling. This resulted in total establishment costs of $129.36 per acre for a planting density of 681 trees per acre (TPA) and $119.36 for 538 TPA. Thinning timing and intensity was determined using a Stand Density Index (SDI). The study used the following upper and lower SDI targets that indicate when to then and how many trees should be allowed to remain so that no growing space is wasted by thinning. Simulated loblolly pine plantations were thinned when they reached an SDI of 55 percent, and thinning reduced the stand to an SDI of 35 percent. These two SDI targets were identified by a recent study as the SDI targets to follow if maximizing timber revenue is a primary objective. These two SDI targets can be applied to all site index and planting density combinations.

The study simulated loblolly pine plantation growth and volumes for the previously mentioned range of SIs, planting densities, and SDI targets. The stands were simulated using the Managed Pine Plantation Simulator. Harvest volumes from thinnings and final harvest were projected for the no thinning management regime (i.e., pulpwood/fuelwood regime) and for the one and two thinning management regime (i.e., sawtimber regimes). For all scenarios a wide range of possible final harvest ages were simulated to allow for identification of the financially optimal harvest age. Foresters use a financial formula called Land Expectation Value (LEV) to project the financially optimal final harvest age and to determine the financially optimal management regime (i.e., no, one, or two thinnings).

The management regime that maximizes LEV is financially optimal. The study results indicate not only maximized LEVs but also the indifference price between pulpwood and sawtimber management regimes for a range of MAR (minimum acceptable rate of return) from 6 to 12 percent. To summarize, the factors that were allowed to vary to answer the question of financially optimal rotation age and management regime are presented in Table 1.

**TABLE 1**

| Regime | Pulpwood Sawtimber |
|---|---|
| Site Index | 50, 60, 70, 80, 90 base age 25 |
| Trees Per Acre Planting | 681 (8′ x 8′), 538 (9′ x 9′) |
| Harvest Age | Variable Range |
| MAR | 6, 8, 10, 12 |
| Price Ratio | Variable Range |

Table 1. Loblolly pine plantation management study variable factors considered for both pulpwood (no thinning) and sawtimber (one and two thinning) management regimes.

Study results indicate that sawtimber rotations, at the historic range of pulpwood to sawtimber price ratios, are financially optimal for all combinations of SIs, planting densities, and minimum acceptable rates of return.

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Indifference price points for each SI showing changes with MAR for each SI are shown for planting densities of 681 TPA (Figure 2) and 538 TPA (Figure 3).

**FIGURE 2**

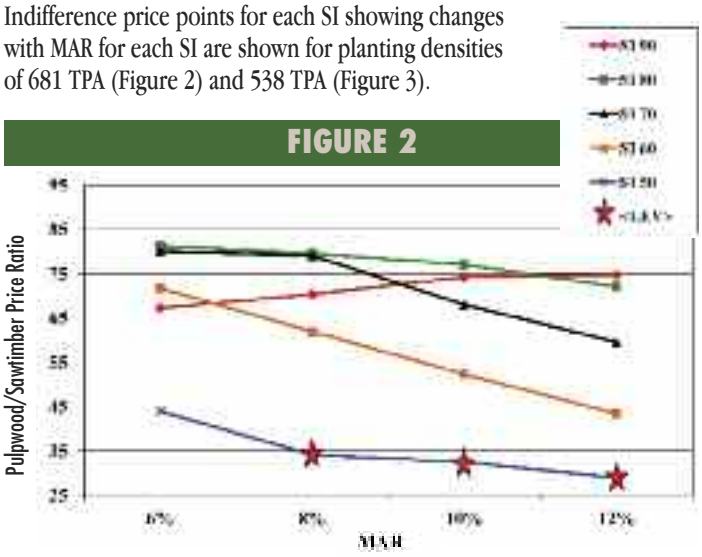


Figure 2. Indifference price points where financially optimal management regimes transition from sawtimber to pulpwood management regimes for planting densities of 681 TPA. Unprofitable rotations indicated by a red star.

**FIGURE 3**

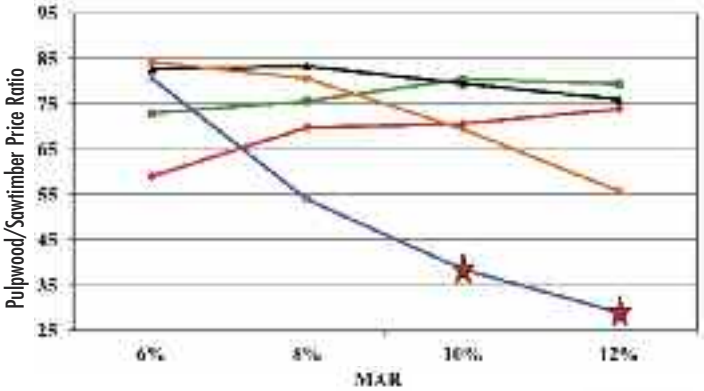


Figure 3. Indifference price points where financially optimal management regimes transition from sawtimber to pulpwood management regimes for planting densities of 538 TPA. Unprofitable rotations indicated by a red star.

### Conclusions

Our results indicate that sawtimber regimes are financially better than pulpwood regimes even at today's depressed sawtimber prices where relative pulpwood prices exceed 30 percent of sawtimber prices. Indeed, relative pulpwood prices would have to increase substantially to 44 percent to 84 percent of sawtimber prices, depending on planting density, site index and minimum alternative rate of return, before pulpwood regimes would become financially preferable to sawtimber regimes. Although fuelwood may be the market of the future, currently fuelwood is a low value product and fuelwood markets only exist in limited geographic areas in Mississippi. Thus it is premature to switch to straight fuelwood management. True, sawtimber markets are depressed, but they should recover well before any trees planted today reach financial maturity.

Other factors also favor managing loblolly pine on sawtimber rotations. Sawtimber rotations provide landowners more options than strict pulpwood regimes. Growing sawtimber can still take advantage of fuelwood markets: thinnings, topwood and the pulpwood component of final harvests can all be marketed as fuelwood if/when fuelwood prices are high while still capturing price premiums for sawtimber. Sawtimber rotations generate a wider range of products: sawtimber, plylogs, poles, chip-n-saw, and pulpwood. Thus, risk is spread across more end markets. Also, sawtimber regimes are far more amenable to non-market values. With only minor trade-offs, wildlife habitat and aesthetics can be easily accommodated in sawtimber regimes. It is also important to remember that loblolly pine management is not an either/or proposition. Early management for both pulpwood and sawtimber regimes is virtually identical. Our study showed that differences in planting density had relatively little impact on returns. Not until the time of first thinning do pulpwood and sawtimber regimes diverge substantially. Even after first thinning, stands can still be harvested for fuelwood.

Finally, it is important to note that while our study showed that sawtimber rotations are generally more profitable than pulpwood rotations, it does not mean that pulpwood rotations are necessarily non-profitable. Under a wide range of site indexes, planting densities, and minimum acceptable rates of return, pulpwood rotations often generated positive LEVs. The important thing to do is get the trees in the ground and get them growing!