# Economic and Operational Feasibility of Short Rotation Hardwood Inventory

**Tom Gallagher and Robert Shaffer**
Instructor and Professor, Dept. of Forestry (0324)
Virginia Tech, Blacksburg, VA 24061

Abstract. Procuring wood during the winter months for a pulpmill in the Southeast has some difficulties, especially in hardwood. Soft ground reduces the operational feasibility of many sites, forcing companies to store hardwood in woodyards for retrieval during wet weather. Intensively managed, short rotation hardwood grown on dry sites could economically supply a pulpmill during a wood shortage and thereby eliminate stop-gap measures taken by procurement organizations.
This paper will discuss the pro's and con's associated with short rotation hardwood plantations, along with its potential. A comprehensive study plan is presented that includes using wood cost from three southeastern pulpmills over a three year period. The study will determined whether short rotation hardwood could be economically substituted for purchased wood.

## INTRODUCTION

Pulpwood consumption across the South has increased steadily over the past decade as production has relocated from other parts of the country and market demand increased (APA, 2000). The South now accounts for over 70% of the pulpwood consumption of the United States. During this same time, hardwood usage in the pulpmills has also increased as a percentage of raw material furnish, resulting in a 16% increase in hardwood consumption. There are many factors behind this increase. In many localities, hardwood pulpwood may be cheaper than pine pulpwood (TimberMart South, 1999). Depending on the product output from the pulpmill, hardwood furnish may be more desirable for some plants because of paper qualities. Some companies have also developed a niche market for themselves by producing a hardwood pulp that is sold around the world where hardwood furnish may not be readily available.

### Concerns for Hardwood Supply in the Southeast

In the South the hardwood resource is generally available at competitive prices, but during specific winter months it may be very difficult to procure, often causing seasonal increases of hardwood prices. This is commonly due to wet ground conditions, which may cause problems with in-woods harvesting and truck transport. While the winter months may not have more rainfall than do the summer months, the reduced evapotranspiration causes soils to remain wetter for longer periods of time. These wetter conditions constrain timber removal since most companies are reluctant to continue harvesting operations when a threat exists to water quality. Also in the winter, rainfall tends to fall slower over a longer period of time, allowing it to soak into the soil (Frederick, 1979). This leads to difficult woods access as roads become saturated and impassable. As a result of the difficult winter season logging conditions, a seasonal increase in hardwood prices often results. This is particularly true since harvesting cost is often the largest component of delivered wood cost.

Additional concerns for hardwood supply arise from local availability. Many paper companies have planted upland sites on company-owned (fee) lands with pine, converting thousands of acres from upland hardwoods to southern pine in search of higher investment returns. This practice has reduced hardwood supply on fee lands over time. Industry owned hardwood can still be found growing on thousands of acres of bottomland sites in many regions of the Southeast, but access and availability may be a problem for many stands due to terrain, soil conditions, a high water table and other environmental concerns.

Most of the remaining hardwood stands are owned by private non-industrial landowners. These owners may not be interested in timber production but focus on hunting and aesthetics. Also, timber availability from these sites may be constrained by steep slopes, swamps, limited road access and marginal volume per acre.

While most reports on region wide timber resources conclude that large quantities of hardwood volumes are present, the availability of the resource for future harvest remains uncertain. Recent political issues have further complicated availability. When companies have located chipmills in areas with abundant hardwood resources, environmental organizations often fuel public concerns about overcutting. Foresters view clearcutting of high-graded stands in the mountain regions as being beneficial for regeneration of more desirable species. However, the public is often skeptical about the increase in clearcutting in a region where "selective" harvesting has historically been used. As a result of these environmental and political concerns, locating chipmills in areas with

extensive hardwood resources may not be an available solution to the hardwood pulpwood demand in some areas.

The traditional solution to wet weather access problems and other raw material availability fluctuations is to increase pulpmill wood inventories during drier periods. To insure an adequate volume of hardwood furnish during the winter months in the South (and throughout the year), pulpmills typically "inventory" hardwood pulpwood on company or supplier woodyards. Wood is bought and stacked for later retrieval when necessary. Most of this material is inventoried for short periods of time (1-6 months), while some wood is inventoried under water sprinklers for longer periods (6-24 months).

Inventory increases typically begin in the Fall and peak around the first of the year (beginning of winter) (International Woodfiber, 2000), and are utilized during the few months of the year when wood purchases are often reduced by difficult logging conditions (Figure 1). The inventory is then further reduced in the spring to a more operational volume based on daily wood consumption. Pulpwood held in inventory has additional costs associated with it due to the extra unloading and loading, some deterioration while in storage, and the cost of the woodyard where the pulpwood is stored. These additional costs associated with this wood storage are considered "insurance" against the pulpmill running out of wood. During a mild winter, this wood may not be needed but must be consumed because it will deteriorate. The stored wood is then supplied to the mill at an above average cost. Purchasing and storing excess wood inventory is a costly operation for pulp and paper companies, but is the traditional way to ensure a constant supply of wood for the pulpmill during the winter period.

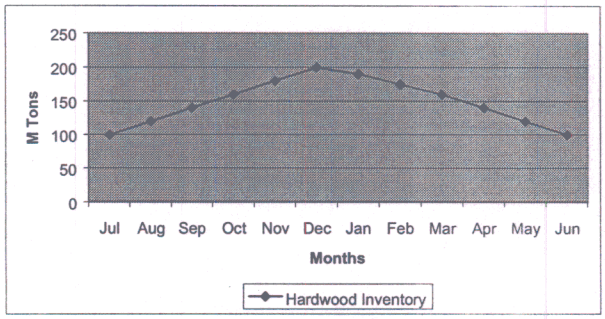


**Figure 1.** Hardwood inventory levels for a typical Southern pulpmill peak around the first of the year.

### Green Storage

In the Pacific Northwest, wood procurement has become a year round problem primarily due to a massive reduction in the volume of timber harvested from National Forests. In response, some companies have established intensively-managed, short rotation, hardwood plantations to supply their mills with fiber (Kaiser et al, 1994) (Figure 2). These plantations are intensively cultivated, irrigated, and fertilized. With this level of intensive management, it is possible to grow 40 tons of dry hardwood fiber per acre on a planned rotation of 7 years (Withrow-Robinson, 1994). In this region, the high costs involved with intensive plantation management are necessary to assure a raw material supply for pulpmills in the region. In the South, the cheaper cost of hardwood during much of the year makes short rotation hardwood plantations more difficult to justify economically. In an analysis completed for the Southeast in 1998, Bar (1998) estimated current prices for fiber and projected costs for fertigated (fertilizer applied during the irrigation process) hardwood plantations. Those findings predicted that it would be several years before hardwood stumpage prices in the South increase to the level necessary to justify intensive culture plantations as a daily source of fiber.

### Research Objectives

The objective of this on-going research project is to determine if strategically located, short rotation, intensively-managed hardwood plantations are economically and operationally feasible in the South as a cost effective alternative to the annual storage of large volumes of hardwood pulpwood inventory. For example, if the procurement organization for a pulpmill has determined that it requires 150,000 tons of hardwood fiber available to carry the mill through the winter months, what savings could occur if alternatively, 120,000 tons were inventoried in conventional storage methods, and 30,000 tons were inventoried on "green hardwood" plantations? During a mild winter, the plantation wood may not be utilized, allowing the trees to grow for another year. Thus, only 110,000 tons would need to be inventoried next year before winter arrives, as the plantations would now make up the other 40,000. The study will examine the biological, operational and economic feasibility of developing and maintaining a "green inventory" short rotation, hardwood plantation as a winter inventory buffer for a southern pulpmill. A model will be developed that can be used by pulp and paper industry firms to determine whether or not a "green inventory" strategy is appropriate for their location.

## METHODS AND PROCEDURES

Three pulpmill case studies will be analyzed. This "green inventory" plantation, perhaps 400 to 800 acres for an average size pulpmill (roughly 3 million tons of consumption per year, with at least 50% hardwood), would be strategically located near the mill, on a well-drained site to allow for winter harvesting. A sandy site would be most practical from an operational standpoint, and fertilization and irrigation would likely be required to enhance the site productivity. The costs and yields for a hypothetical hardwood plantation will be determined,

with the model output being an estimated price per ton for the short rotation fiber delivered to the pulpmill.

**Developing Hardwood Plantation Growth and Yield Estimates for the Model**

Growth and yields for poplar species have been studied for many years. Ek and Dawson (1976) looked at *Populus Tristis* grown under intensive culture in Wisconsin. Their findings indicated height growth of 6 – 8 feet and diameter growth of 1 inch per year. A study conducted in the Southeast (Cox and Leach, 2000) yielded height growth of 10 feet and diameter growth of 1.1 inches each year for four-year-old plots of cottonwood. This amounted to just under 1200 cubic feet per acre of volume. Sycamore and sweetgum trials at the same site were not as productive. A recent personal visit to a forest industry site in South Carolina growing eastern cottonwood also supported these findings. Cottonwoods in various age classes were averaging similar growth rates of 10 feet of height and 1 inch of diameter per year.

The U. S. Department of Energy has been investigating hybrid poplar for biomass production for many years. In a recent report (De La Torre Ugarte et.al., 2000) on bioenergy crop production, hybrid poplar yield in the Southeast averaged 4.5 dry tons/acre/year.

While several studies on West Coast short rotation plantation yields provide information on volumes available from these plantations, growth and yields for this study will come from estimates of existing industry trial cottonwood plantation trials in Florida, Missouri and South Carolina. Summary diameter and height estimates will be used determine volume (tons) per acre over various ages.

**Determining Hardwood Plantation Silvicultural Costs**

To evaluate all the costs for a short rotation plantation in the southern coastal plain region, costs will be estimated for the land purchase, site preparation and planting, and annual management practices such as fertigation and weed control. These estimates will be summarized in a spreadsheet by category on a year-by-year basis so a sensitivity analysis can be done to determine what effect cost fluctuations will have on the final product cost.

Land costs – The value of bare land for plantation establishment can vary greatly across a region. For this study, land costs will be determined from fair market value comparisons of sites in the vicinity of the pulpmills. Local real estate businesses who specialize in farm transactions will be surveyed. In addition, local consulting foresters will also be asked to verify the values. As mentioned earlier, dry sandy sites with good road access will be required.

Initial irrigation costs – there are several companies in the Southeast region who provide design and installation of irrigation systems for farm use. At least three companies will be asked to supply the estimated cost for a complete drip irrigation system and their expectations of annual costs. The costs from the three suppliers will be averaged for input to the model. Following standard accounting procedures, the costs for the installation of the drip irrigation system along with the land costs will be capitalized and spread over 15 years (the equivalent of two rotations).

Site preparation costs – *Forest Landowner* magazine publishes a survey every other year summarizing various site preparation costs for the southern region. The most recent survey was published in March of 2001 (Dubois et. al., 2001). These estimates will be verified with local land and timber personnel for each pulpmill site to ensure they are representative of the area.

Planting costs – Private and state nurseries in the southern region who offer cottonwood cuttings for plantation establishment will be surveyed to determine the cost of cuttings. Hand planting will be the method for establishment because the cuttings must be placed correctly at the drip tube openings. Cost of hand planting will be obtained from industry sources.

Annual maintenance costs – the cost of weed control and operating the irrigation system to supply water, fertilizer and insecticides will be estimated for each year. Weed control costs will decrease each year as the tree crowns develop and begin to shade out the forest floor thus preventing most weed germination. Costs for a backpack spray application completed by contractors will be estimated for years one and two. Fertilizer needs will increase each year as the trees require more nutrients for maximum growth. Insecticides are required on an "as needed" basis, so an application each year will likely be included. Both fertilizer and insecticide can be applied through the irrigation system, so sample chemical companies will be asked for material cost estimates.

Supervision – While most costs will be calculated on a contract basis, it will likely take one or two full time employees to maintain the plantations, and this labor cost will be included in the model. Interviews with companies conducting these operations verify that two people are typically required because of the necessary constant monitoring of the irrigation system, as well as the periodic sampling for insect presence.

**Developing the Economic Feasibility Model**

The economic feasibility of short rotation hardwood "green inventory" plantations for certain Southeastern pulpmills will be analyzed in two ways:

- as a direct cost comparison to other wood deliveries
- in wood cost savings by keeping "green" inventory instead of roundwood inventory on woodyards.

For a direct comparison with other wood deliveries, a model will be developed to summarize all the costs for a short rotation hardwood plantation, and combined with yield, a price per ton for wood delivered to the pulpmill from this source will be calculated for each year. Harvesting costs for two potential systems, (1) a roundwood system and (2) an in-woods chipping system, will be included to determine a delivered price of the fiber to the pulpmill. Historical wood cost data from three cooperating pulpmills will be collected for a three-year period. This data will include the most expensive source for hardwood pulpwood and chips purchased by the mill each month. These maximum cost wood sources will then be compared to the estimated hardwood plantation delivered price. This comparison should indicate whether short rotation plantations are economically feasible for the sample pulpmills on a direct wood cost basis.

A second analysis will examine the effect of carrying green hardwood plantations as an alternative to roundwood inventory on woodyards as a strategy to supply the pulpmill over the course of the year. For those years when the delivered cost of fiber from the green inventory plantations are higher than the firm's highest actual wood costs, an assumption will be made that the hardwood plantations are not harvested. The remaining volume will then be used to "replace" wood that would likely have been purchased and inventoried on company wetyards. Theoretically, savings should accrue since the company will buy less wood to be stored on woodyards (a more expensive option) and replace it with wood purchased directly from the woods to the pulpmill. If less wood is purchased during the inventory building phase on a given year, savings should occur in total wood cost. The additional volume in "green inventory" hardwood plantations would only be harvested when the procurement manager for each pulpmill determines inventory levels at the pulpmill have reached a critical stage. If a dry winter occurs, and the pulpmill wood inventories do not drop below acceptable levels, the hardwood plantation will be left standing to grow another year. Then, the following winter, a reduced volume of wood will need to be purchased for storage on company woodyards. Assuming this occurs over a period of several years, a substantial reduction in total, overall wood cost may be achieved.

## CONCLUSION

This paper has discussed the pro's and con's of green plantation storage versus traditional woodyard storage of hardwood in the South. A detailed study plan has been presented and will be carried out at Virginia Tech.

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