USING SHORT-ROTATION HARDWOOD PLANTATIONS AS "GREEN" INVENTORY FOR SOUTHEASTERN PULP MILLS.

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ABSTRACT

As a routine wood source for a pulp mill, recent past studies have shown that intensively-managed, short-rotation hardwood plantations are not cost effective. The objective of this study was to determine if these plantations may be cost effective as "green" inventory, replacing some portion of high cost remote woodyard inventory. Three southeastern pulp mills were used as case studies in a net present value analysis. Short-rotation hardwood plantations of eastern cottonwood (*Populus deltoides*) were used to replace a portion of remote woodyard inventory, with wood delivered to a pulp mill only when inventory levels become critical. If this "green" inventory is not used, these plantations continue to grow until needed. With current yield from an experimental fiber farm, short-rotation plantations were not cost effective as "green" inventory. However, if yield could be increased approximately 33% through expected genetic improvements, all three pulp mills could have reduced overall wood cost by establishing a fiber farm.

INTRODUCTION

Procuring wood, especially hardwood, during the winter months for a pulp mill in the Southeast has some difficulties. Soft ground reduces the operational feasibility of many sites, forcing companies to store hardwood in woodyards for retrieval during wet weather. Short-rotation, intensively-managed hardwood plantations grown on dry sites could replace some volume companies are storing in remote woodyards.

An earlier part of this study determined hardwood fiber farms are expensive to establish and the wood from these hardwood plantations delivered to a pulp mill is well above that of normal delivered furnish (Gallagher, 2003). It was also a much higher cost than what Bar (1998) determined, probably due to yield differences. Both reports indicate that it could 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. However, short-rotation hardwood plantations could be used as a "green inventory" alternative to supply a pulp mill during severe weather. "Green inventory" refers to a strategically located, intensively managed, short-rotation hardwood plantation (fiber farm) that could be harvested at any time to provide a surge of wood into the pulp mill.

Wood cost savings should accrue since the company will buy less wood to be stored on remote woodyards (a more expensive option) and will replace it with wood purchased directly from the woods to the pulp mill. If less wood is purchased during the inventory building phase in a given year, savings should occur in total wood cost. The additional volume in "green inventory" hardwood plantations would be harvested only when the procurement manager for each pulp mill determines inventory levels at the pulp mill have reached a critical stage. If a dry winter occurs, and the pulp mill 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 will need to be purchased for storage on remote company woodyards. Assuming this occurs over a period of several years, a substantial reduction in total, overall wood cost may be achieved.

Wood stored in remote woodyards typically carries a $1 O/ton premium over deliveries directly to the mill from the woods (Martin, 2001). Wood stored at a remote woodyard must be unloaded, stored, and then reloaded onto trucks or railcars. These additional operations, along with some deterioration as the wood ages in the woodyard, add cost to the material. Additionally, remote woodyard material must then be transported to the pulp mill, further increasing costs. The amount of additional costs will vary with age of the wood (amount of deterioration), distance to the mill, and size of the woodyard, but $10/ton is typical. Thus, if 10,000 tons of material were available in “green inventory” and could replace an equal amount of remote woodyard inventory, a potential $100,000 savings in wood cost during the year ($1 O/ton savings x 10,000 tons) could be realized. Although our earlier analysis showed that wood deliveries from a fiber farm cannot compete on a cost basis with gatewood, this additional savings over remote woodyard storage may offset the relatively high cost of the fiber farm material used when pulp mill wood supplies are low.

Thus, this research project has the following specific objectives:

> Using a decision model developed in an earlier study, determine the cost feasibility of using short-rotation, intensively managed plantations as “green inventory” in actual pulp mill inventory situations. Actual hardwood inventory and costs for three southeastern pulp mills will be used as case studies to validate the feasibility of “green inventory”.

MATERIAL AND METHODS

The cost feasibility of short-rotation hardwood plantations as “green inventory” for Southeastern pulp mills was analyzed by determining the total wood cost savings of keeping “green” inventory instead of roundwood inventory on remote woodyards. Three cooperating southeastern pulp mills who supplied hardwood wood cost and inventory levels over a three-year period were used as case studies to determine if using short-rotation hardwood plantations as “green inventory” would have reduced wood cost.

For each of the three years, hardwood inventory levels were analyzed to determine if pulp mill inventory ever reached a critical level. The critical level was defined by procurement personnel from each mill and was determined to be when actual inventory levels dropped below 50% of inventory goal; however, it will vary slightly with season. Inventory goals are set by management and are determined to be the amount of wood the pulp mill needs to store each month to effectively buffer day-to-day and week-to-week inventory fluctuations, and these goals provide a set probability that the mill will not run out of wood, causing a curtailment in paper production. Actual inventories, of course, vary based on consumption and deliveries. Only when inventory reached a critical level would green inventory be harvested and delivered to the pulp mill.

Savings could occur each year for the available volume of “green” inventory as an equivalent volume of roundwood would not be purchased and stored at remote woodyards. The savings for this volume was the $1 O/ton additional cost associated with remote woodyard roundwood.

Each pulp mill was analyzed as a separate operation, first using low yield and then high yield plantations. For each analysis, it was assumed that a fully operational fiber farm was already established with equal acres in each age class for the selected rotation length in the decision model, as though the green inventory system were already up and running after initial establishment in order to understand how a working fiber farm could influence annual operations and costs. For each year at each pulp mill, there are three potential cash flows: 1) costs to operate the fiber farm, 2) annual savings from the volume of wood in hardwood plantations, and 3) replacement of high cost deliveries.

Costs each year to operate the fiber farm were summarized and considered as expenses. These costs were calculated on the acres in each age class of plantation on the fiber farm. Savings were totaled by multiplying the amount of volume available from the hardwood plantations by the woodyard premium ($10/ton). Volume was only included from plantations that were age 5 and higher.

The last annual cash flow in the decision model came from offsetting wood purchases with plantation wood. This occurred only during a year when green inventory was harvested. All the costs associated with the hardwood plantations were already accounted for on an annual basis in the decision model as an expense. When the green inventory wood was harvested, it was then delivered to the pulp mill at the average harvesting cost for the area (all stumpage cost was included above as expenses). This plantation wood offset the highest priced hardwood delivered during a similar time period (within 2-3 months). Therefore, the price differential between plantation wood and these suppliers was accounted as savings.

All the costs and all the savings over the three-year period were used as cash flows in a net present value analysis, similar to the way Lothner (198 1) analyzed plantations in his study. Two scenarios were analyzed with the decision model for each pulp mill. The first analysis was done using the lower yield plantations that are representative of the operational, industry fiber farm located in the Southeast. A second scenario was completed for each pulp mill using the higher yield plantations, assuming that genetic improvements and operational efficiencies result in the higher yielding fiber farms.

While the decision model was being used, if a dry winter occurred and critical levels were not reached, the volume was carried over to the next year and additional volume was added due to growth. Also, in the event of several dry years in a row, an assumption was made to harvest any plantations reaching age 10.

RESULTS AND DISCUSSION

Pulp Mill #1 Analysis

Pulp mill 1 (Figure 2) had the lowest hardwood inventory goal of the three mills, peaking at 80,000 tons during the winter. For this first analysis with the low yield decision model, it was assumed a 400-acre plantation was already established. All plantation costs for that year were $199,321. There were 8323 tons of green inventory available, therefore, that amount of less wood was purchased and stored in remote woodyards at a savings of $1 O/ton and totaling $83,229.

The hardwood inventory level for pulp mill 1 was input into the decision model. During year 1, actual inventory level never reached the critical level of less than 50% of goal, so no short-rotation plantations were harvested. All the acres across each age class were carried into the next year.

Year 2 plantation costs of $186,002 and savings of $122,335 (12,234 tons x $1 O/ton) are shown in Table 1. During year 2, low inventory levels in February resulted in 57 acres (1 age class) of hardwood plantation being harvested with a total of 3984 tons of fiber. Looking at hardwood deliveries to the pulp mill during that same period, some woodyard wood delivered for $34.21/ton. Roundwood from the plantations offset that woodyard material and delivered for $12/ton (because all the other plantation costs were already accounted for), so an additional wood cost savings of $85,294 was realized.

During year 3, low inventory levels in October caused by reduced deliveries of wood resulted in 57 acres of hardwood plantation being harvested, again with a total of 3984 tons of fiber. These fiber farm deliveries offset some roundwood that arrived at the mill at a of cost $33.74/ton and generated a wood cost savings of $84,656.

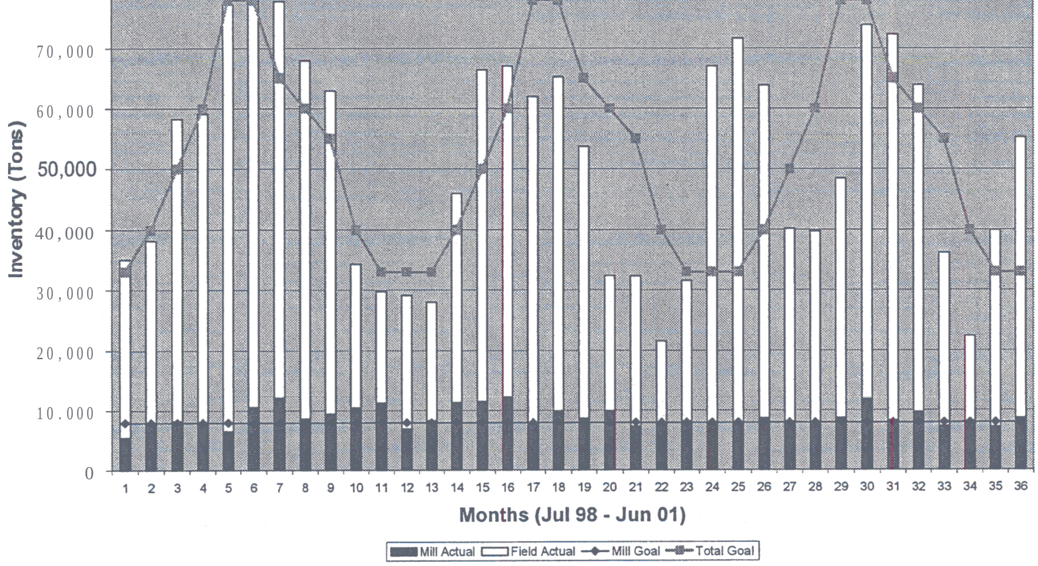

Figure 2. Hardwood inventory levels for pulp mill 1. The actual mill and field (woodyards) inventory are stacked as a bar against the lines that indicate inventory goals.

A three-year summary of the costs and savings are shown in Table 1. The net present value of this cash flow was a negative $83,694. Even though annual cash flows were positive for two of the three years, the fiber farm with a low yield was never able to make up for the first year loss.

Table 1. Summary of all cash flows ($) for a net present value analysis of green inventory for pulp mill 1 with low yield plantations on a 400-acre fiber farm.

	Plantation costs	Inventory savings	Wood cost savings	Annual cash flow
Year 1	199,321	83,229	0	-116,092
Year 2	186,002	122,335	85,294	+2 1,627
Year 3	198,713	122,454	84,656	+8,397
	Net present value =	($83,694)	Average=	-28,689

Finding the net present value negative for the low yield plantations was expected given the high delivered cost for hardwood plantations developed in the previous chapter. A second scenario was run using the earlier assumption of higher yielding plantations and therefore lower costs per unit. These higher yields should come through genetic improvements and operation optimization (Stanturf, 2003). The same 400-acre farm is established (Table 2), so plantation costs for the three years of the analysis are the same. Inventory savings are higher because there is additional volume available each year from the higher yielding plantations.

The need to harvest follows a similar pattern to the first scenario: no wood was cut in year 1, 57 acres were harvested in year 2 and 57 acres were harvested in year 3. Wood cost savings for the offset deliveries amounted to $111,702 in year 2 and $112,896 for year 3. The net present value for this scenario is a positive $63,485 (Table 2). While year 1 was again a negative cash flow, years 2 and 3 had much higher positive cash flow from both inventory and wood cost savings, thereby resulting in a positive three-year average.

Table 2. Summary of all cash flows ($) for a net present value analysis of green inventory for pulp mill 1 with high yield plantations on a 400-acre fiber farm.

	Plantation costs	Inventory savings	Wood cost savings	Annual cash flow
Year 1	199,321	111,029	0	-88,292
Year 2	186,002	163,175	111,702	+88,875
Year 3	198,713	163,333	112,896	+77,5 16
	Net present value =	$63,485	Average=	+26,033

The benefit of getting additional volume from the high yield plantations for the same plantation costs, thereby allowing more woodyard inventory to be offset annually and more deliveries offset when plantations are harvested is shown by the positive NPV. While the volume is still nowhere near what Bar (1998) estimated, the additional volume is enough to the necessary savings to justify a fiber farm.

Pulp Mill #2 and 3 Analyses

The inventory graphs are not shown because of space limitations, however for both mills, they were able to keep actual inventory at or near inventory goal most of the time during years 1 and 3. But for both pulp mills, year 2 was impacted by slow deliveries and inventory fell to critical levels. For these analyses, both mills required multiple age classes of green inventory to be harvested in year 2 to prevent curtailment of pulp mill operations.

The year-to-year costs and savings for each individual analysis from the decision model can be found in Appendix B. A summary of all the analyses is found in Table 3. Pulp mills 2 and 3 were similar to pulp mill 1 in that they all had negative net present values with low yielding hardwood plantations. All 3 mills had a positive NPV once the higher yielding plantations were involved.

The underlying effect that drives the savings for fiber farms is not having to store large quantities of wood on woodyards to prevent pulp mill curtailment. It's the stochastic nature of wood deliveries that Galbraith and Meng (198 1) first reported when doing inventory analysis that allows this assumption. And while supply, demand and production lead time change regularly due to environmental restraints, as shown by LeBel and Caruth (1997), some wood deliveries will still make it to the pulp mill. Only in the event of an extended drop in deliveries would fiber farms then support procurement efforts and prevent the mill from possible curtailments.

Table 3. Summary of the net present values for low and high yield hardwood plantations as green inventory for three southeastern pulp mills (numbers in parenthesis are negative).

Scenario	Pulp Mill	Yield	Acres	Net present value	Average annual cash flow
1	1	Low	400	($83,694)	($28,689)
2	1	High	400	$63,485	$26,033
3	2	Low	600	($584)	($2,640)
4	2	High	600	$236,820	$84,150
5	3	Low	600	($47,533)	($17,669)
6	3	High	600	$168,040	$61,521

CONCLUSIONS

The objective was to examine the cost and operational feasibility of establishing a strategically located, intensively-managed, short-rotation hardwood plantation ("fiber farm") to serve as "green inventory" for a southern pulp mill. Once established, the green inventory should allow the firm to reduce the traditional amount of purchased and stored woodyard "winter" inventory that may be needed to insure an adequate raw material supply. During the winter, if and when pulp mill inventory declines to a predetermined "critical" level, some portion of the green inventory would be harvested, otherwise it would remain growing for potential use in a future year.

The results of the green inventory analyses on three cooperating southern pulp mills show that the concept may be operationally feasible and cost-effective under the following conditions:

a. The pulp mill uses similar practices as the three case study pulp mills to build inventory for the winter, storing wood in remote woodyards for later retrieval when deliveries are slow.
b. Yields from the fiber farm increase over time above volumes previously reported by the limited operational trials in the South. This is reasonable to expect, given the documented increase in yields realized from existing, large-scale operations in the Pacific Northwest through genetic manipulation.
c. Wood from the fiber farm would not be needed or used every year, allowing substantial cost savings from reduced woodyard inventory to accrue and additional growth to occur during periods of the rotation. If (expensive) fiber farm wood deliveries had to be used too frequently, any woodyard inventory savings would likely be depleted.

In summary, wood from intensively managed, short-rotation hardwood plantations is currently too expensive to become a regular source of furnish for southern pulp mills any time soon, but may, under certain circumstances, be strategically used in a limited capacity as "green inventory" to reduce overall wood cost through inventory savings for some mills.

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