ECONOMICS-BASED SILVICULTURE IN LOBLOLLY PLANTATION MANAGEMENT

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ABSTRACT

In a vertically-integrated forest products firm, owned forest land is generally managed for maximum yield of the needed type of fiber. When production falls below objective, additional fiber must be purchased to supply requirements and raw material cost is increased. Available growth and yield models indicate the potential of well-managed loblolly plantations, and the loss of yield and value that occurs with sub-standard stocking and/or hardwood competition. Thus, the relative economic performance of a stand by expected outcome from silvicultural treatments may be assessed with a value index that combines net present value and the cost to replace lost production. By using a model incorporating this approach, planning and selection of operational silvicultural treatments can be improved.

INTRODUCTION

Inland Container, like most large forest products companies in the south, owns a sizeable acreage of forest land. Fiber grown on company land reduces our dependence on outside suppliers and lowers total raw material cost. Pine plantation management is the standard management method on the land base, and it has the potential to produce large amounts of fiber. However, this is a capital intensive enterprise subject to some risks. We know that certain unfavorable stand conditions can significantly reduce productivity, but no good tool for assessment of the financial impacts of such conditions has been available.

For businesslike forest management planning, Inland Container employs the MaxMillion model, which was developed at the University of Georgia's School of Forest Resources. This is a comprehensive model for scheduling harvest and regeneration of
a forest property to meet fiber production objectives, and to predict financial performance. Inventory projections for future time periods are obtained using appropriate growth and yield models, while costs and returns are estimated from current data and expected trends. The program generates data matrices that contain production and financial statistics for each stand relating to the defined management regimes, and a linear programming routine selects the optimum solution that satisfies specified constraints on period harvest quantities and treatment acreage.

MaxMillion can be run with a solution objective of maximum net present value or minimum total fiber cost. The net present value solution considers the forest a stand-alone operation managed to produce highest return from sale of the harvest. The minimum cost solution deals with the company harvest and outside fiber purchases as complementary elements of a total fiber supply, and determines how these can be combined for greatest cost effectiveness over the scheduling period. We have found little difference in the stand harvest sequence on company land between the two approaches, but the economic implications are quite different.

In a minimum cost harvest scheduling solution, representing a vertically-integrated organization, the opportunity to reduce total fiber cost through maximum production on company lands becomes obvious. The goal for our new plantations is full stocking and low competition, but not all stands meet that expectation. Every under-performing stand results in lost fiber production, a reduction of allowable harvest, and the eventual purchase of additional outside fiber to meet mill requirements. The consequences of this "lost yield" are not readily apparent at the operating level, however, and usually do not influence silvicultural decisions. A tool incorporating this economic reality was needed to assist with plantation management decisions.

MODEL DEVELOPMENT

The Virginia Tech ECONHDWD model was selected as a base because it predicts loblolly plantation yield according to pine stocking and hardwood competition level and provides a detailed financial analysis, including net present value (NPV). To show the cost of "lost yield" in a stand, an "Adjusted Net Present Value" was added. Lost yield is the difference in projected yield from a fully stocked stand with no hardwood (target stand condition) and projected yield of the actual stand. Adjusted NPV of a stand is calculated by subtracting the cost to replace lost yield from the conventional NPV. Combining these values recognizes forest productivity as a key factor in total fiber cost and puts the management of owned lands into proper perspective.

By use of this model, which we named LOBECON, one can extend the concept of forest-level cost minimization to individual stands. Specific conditions may be evaluated to determine if the stand contributes positively or negatively to financial
performance. In silvicultural planning, comparison of expected results from treatment options leads to better choices, higher productivity, and fewer costly mistakes. For budgeting, the model can aid in prioritization of stands for treatment, and show justification for intensive treatments to attain full site productivity.

APPLICATIONS

Examples are provided to illustrate the application of LOBECON to analysis of expected treatment outcomes in stand establishment and stand release.

Model Inputs and Assumptions

a. Stand conditions: loblolly plantation, site index 60 feet (base age 25 years), 700 trees per acre planted, no thinning, variable hardwood component, harvest at age 30, yield expressed in cords of pulpwood and chip-n-saw.

b. Economics

(1) Discount rate 4 percent (uninflated).

(2) Management/administrative cost $10 per acre pre year, fiber procurement cost $6 per cord (Prof. Tom Harris, University of Georgia - personal communication).

(3) Pine pulpwood stumpage $29 per cord, pine chip-n-saw stumpage $70 per cord, hardwood pulpwood stumpage $11 per cord (Timber Mart South averages for Georgia, 1994).

(4) Site preparation cost $92 per acre, pine seedling cost $32 per thousand, planting cost $44 per acre, release cost $59 per acre (Forest Farmer Manual, 1992 - inflated 5 percent for 1994 estimate).

Stand Establishment

Figures 1 through 4 display a range of projected outcomes for a new plantation, according to impacts of pine survival and hardwood competition problems.

An example of the model estimates of harvest age diameter distribution for optimum (full stocking, no hardwood) and typical (80% survival, 10% hardwood) conditions appears in Figure 1. Clearly, the optimum stand produces more volume and more higher value trees.
Figure 2 shows projected yield for pine survival ranging from 100% down to 50%, and hardwood basal area ranging from 0% up to 30%. Note the gradual decline of yield across stocking levels, and the larger steps between hardwood levels; 30% hardwood cuts yields by more than half.

Figure 1

LOBLOLLY PLANTATION DIAMETERS, AGE 30
OPTIMUM AND TYPICAL STAND CONDITIONS

Figure 2

PROJECTED YIELD OF LOBLOLLY PLANTATION
AGE 30 ON 80% SURVIVAL 8% HWD

In Figure 3, Conventional NPV is depicted for the same plantations as in Figures 1 and 2. Here, all but the worst regeneration outcomes show positive NPV, which may justify acceptance of low-productivity stands when NPV alone is considered. The more productive stand conditions clearly have higher value, however.

Figure 4 presents the Adjusted NPV for these same plantation conditions. The curves shift dramatically, showing a rapid decline in value (contribution to cost minimization) with unfavorable stand conditions, and a narrowed range of positive values. This emphasizes that it is essential for pine plantation establishment treatments to produce well-stocked stands with low hardwood competition in order to realize the expected benefits from company lands.

Stand Release

Comparison of projected diameter distributions in a stand with 80% survival and 20% hardwood, unreleased, and released with 80% effectiveness is provided in Figure 5. A marked improvement of the predicted stand condition at harvest is apparent for the stand with early (age 3) release.
Figure 6 illustrates projected yield response to stand release from 20% hardwood basal area, across survival levels, along with the optimum (top) for comparison. This indicates that significant volume gains are possible with early release treatment.

**Figure 3**

NPV OF LOBLOLLY PLANTATION
AGE 30, 60 OUT BY SURVIVAL & S HWD

**Figure 4**

ADJUSTED NPV OF LOBLOLLY PLANTATION
INCLUDING COST TO REPLACE LOST YIELD

**Figure 5**

LOBLOLLY PLANTATION DIAMETERS, AGE 30
RESPONSE TO AGE 3 RELEASE

**Figure 6**

AGE 30 YIELD WITH AND W/O RELEASE
STAND WITH 30% HWD BA & AGE 3

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Net Present Values for these same stands at age 3, ignoring sunk cost, but including release cost appear in Figure 7. These figures show increased stand value is attainable with release, even when hardwood control effectiveness is only 50%.

In Figure 8, it is apparent the gain in Adjusted Net Present Value with release is relatively larger, due to reducing the cost of replacement fiber required to complement the harvest from unreleased stands. Further analysis indicates that with as little as 10% hardwood basal area, the gain in Adjusted NPV might justify release. Due to the smaller gain, such treatment should be ranked against all other stand treatments under consideration to obtain maximum results from the expenditure.

The potentially large gain in Adjusted Net Present Value projected for release treatments somewhat obscures the fact that a higher stand value is always obtained by doing the job right at time of stand establishment, rather than correcting problems later.

**Figure 7**  
AGE 3 NPV FOR STANDS WITH & W/O RELEASE  
NO SUNK COST-EXCLUDES RELEASE COST

**Figure 8**  
GAIN IN ADJUSTED NPV WITH RELEASE  
FROM 20% HARDWOOD AT AGE 3

**SUMMARY**

In a vertically integrated forest products organization, any reduction of fiber productivity on company land is costly due to the requirement for buying replacement fiber. Low pine survival and hardwood competition can both reduce expected yield and
Net Present Value in loblolly plantations. Combining the conventional net present value of a plantation with the cost to replace lost fiber production gives a new criterion, Adjusted Net Present Value, to best represent the economics of managing owned forest land.

Adjusted NPV suggests there is little room for mistake in plantation establishment. The example shows that survival must be 70% or better, and hardwood cannot be more than about 10% of stand basal area to maintain a positive value. Regarding stand release; the example with Adjusted NPV points to favorable response as low as 10% hardwood basal area when release efficacy is 50% or greater.

Evaluation of management options with Adjusted Net Present Value emphasizes the importance of sound forest management planning and the high payoff from productive use of owned forest lands. Application at the stand level provides valuable guidance for silvicultural decisions in loblolly plantation management.

REFERENCES


Timber Mart South 1994 Yearly Summary. Timber Mart South, Inc., Highlands, N.C.