1985

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ABSTRACT. A major activity of forest industry is supplying their mills with wood. There are four options for wood procurement: fee land, lease land, landowner assistance programs, and open market. The task of the corporate planner is to allocate the limited budget among these options in such a way that the needed volumes of wood are procured at the least cost. A methodology has been developed to aid in this capital budgeting process and has been incorporated in an easy-to-use computer program.[1]

Millions of acres of timberland are owned and managed by the forest industry, but most companies are far from being self-sufficient in supplying their own wood needs. Therefore, a major activity of these companies is supplying their mills with needed wood. The cost of the wood may be reduced by guaranteeing that the needed volume will be available at the appropriate time, in close proximity to the mill, and on sites that are relatively inexpensive to log. This can be accomplished by four wood procurement strategies:

(1) purchasing fee land for timber harvest;
(2) leasing land for timber harvest;
(3) assisting private nonindustrial forest (NIPF) landowners to increase timber production on their lands; and
(4) buying wood on the open market. This includes: (a) purchases made by company procurement foresters, (b) wood purchased under contracts with wood dealers, (c) "gatewood" purchases from anybody who drives up with a truckload of wood, and (d) chip purchases (including mill residue and whole tree).

Because of the high cost of land acquisition and forest management, many companies are looking at alternatives to fee land acquisition as a source of wood. Although the success of leasing land varies from company to company, it is an alternative for ensuring supply. Open-market procurement is a common method of obtaining wood, but neither the available quantity nor the price can be predicted into the long-term future. Assisting private landowners with various forest management activities has been initiated by many firms in the forest industry throughout the Southeast. This may be done under a formal contract (requiring that the company be given first refusal rights for the timber), or it may be as simple as a handshake and a hope by the forester that one day his company will have the opportunity to buy the timber.

The difficult job for the corporate planner arises when the company allocates its budget for wood supply. Which combination of alternative opportunities should be chosen? How much should be invested? Will these investments ensure that the mill will be supplied to capacity? Are these investments the most cost-effective means of procuring the needed quantities of wood?

We outline here a methodology of capital budgeting for the purpose of evaluating investment opportunities in landowner assistance programs and determining the optimum allocation of capital for wood procurement, and, further, preview a computer program which uses this method.

COSTS AND PROBABILITIES OF WOOD PROCUREMENT

When a timber company manages its forest lands there is a high degree of certainty that, at some future date, the wood will be available to the company. The mill is less likely to receive the wood in those companies that have woodlands as one profit center and

[1] The authors acknowledge the technical and financial assistance of Alabama River Woodlands, Inc., Monroeville, Alabama, Union Camp Corporation, Savannah, Georgia and the Southeastern Forest Experiment Station, USDA Forest Service, Asheville, North Carolina in the research and development related to this project. Paper No. 8914 of the Journal Series of the North Carolina Agricultural Research Service, Raleigh, North Carolina 27650.

procurement as another. In addition, fire, wind, insects, and diseases may reduce the certainty of procurement by as much as 2%. When a company enters into an assistance agreement with a landowner (LAA), there is even less certainty that the company will obtain the wood.

One method of dealing with the risk associated with any investment is to assign a probability to classes of investment alternatives and to calculate a probable net present worth (Weston and Brigham 1979). For example, assume that two mutually exclusive investment alternatives, A and B, are under consideration. If investment A will yield a net present worth of $9,000 and investment B will yield $6,000, then investment A will be chosen because of its higher net present worth. If it is known that the probabilities of success are .50 for A and .80 for B, then the net present worth of each investment can be multiplied by its probability to derive the probable net present worth. In this case, project B would be the preferred choice because the probable net present worth for B would be $4,800 and for A it would only be $4500.

A detailed discussion of all of the costs which may be incurred to secure the needed volume of wood at a mill would be lengthy and would vary from one procurement area to another and from one corporation to another. However, most costs would fit one of the following categories:

(1) initial reforestation costs (e.g., site preparation, seedlings, planting, marking seed trees, etc.);
(2) annual or periodic management costs (e.g., fire protection, precommercial thinnings, management plans, leasing fees, etc.);
(3) landholding costs (for company lands this would include the cost of capital, property taxes, etc.);
(4) procurement costs (company forester's time and equipment);
(5) stumpage costs;
(6) logging costs;
(7) woodyard costs; and
(8) transportation costs.

Of these costs, some, but not necessarily all, will be incurred under each of the four wood procurement strategies. Table 1 illustrates which costs are likely to be incurred by a timber company under each of the various procurement strategies. For example, open-market procurement requires that the company incur costs for procurement, stumpage, logging, woodyards, and transportation. For wood obtained from company-owned lands, the company may incur costs in all categories except procurement and stumpage. Depending on the type of landowner assistance agreement (LAA) program, the company may incur costs in all categories except landholding.

Table 1. Costs which may be incurred by a company under the four wood procurement strategies.

	Wood procurement strategy			
Type of cost	Company-owned lands (fee land)	Leased land	LAA program	Open market
Initial reforestation	Y[1]	Y	Y	N
Annual or periodic management	Y	Y	Y	N
Landholding	Y	Y	N	N
Procurement[2]	N	N	Y	Y
Stumpage[2]	N	N	Y	Y
Logging	Y	Y	Y	Y
Woodyards	Y	Y	Y	Y
Transportation	Y	Y	Y	Y

[1] Y = Yes, cost may be incurred; N = No, cost not incurred.
[2] Fee wood (wood from company-owned and leased land) is not necessarily free. In those companies that have different profit centers, fee wood is a cost to the procurement and mill group and a revenue to the land group.

DETERMINING PROBABLE PRESENT VALUE OF PROCUREMENT COSTS

To determine the present value of costs allocated toward securing a given volume of wood in a given future time period, all costs are discounted to the present as follows:

$$PVC = I_o + \sum_{t=0}^{n} \frac{C_t}{(1 + r)^t} + \sum_{t=0}^{n} \frac{S_t}{(1 + r)^t} \qquad (1)$$

where:

PVC = present value of costs per acre
I_o = initial reforestation costs per acre
C_t = annual or periodic management, landholding, and procurement costs per acre
S_t = stumpage, logging, woodyard, and transportation costs per acre (these and the procurement costs are derived by multiplying the cost per unit of wood times the number of units harvested per acre)
r = discount rate
t = year that cost occurs
n = number of years of investment

To determine the PVC per unit of wood harvested, equation (*1*) is divided by the number of units of wood harvested per acre.

There is some degree of risk associated with procurement investments. If a company must be assured of securing a certain quantity of wood, then a probability must be incorporated into equation (*1*) to compute the probable present value of costs ($PPVC$) of the wood procurement investment. Imagine a company that needs, at a specified future date, 10 units of wood, and it can invest in any or all of several different landowners who each produce 10 units of wood. If the probability (P) of procurement from any given landowner under its LAA program is .5, then the probable yield from any particular landowner is 5 units of wood (.5 × 10 units). Therefore, for the company to secure the 10 units of wood it must invest in two landowners. Because the company must invest in two landowners, it will pay initial reforestation costs (I_o) and annual or periodic management and procurement costs (C_t) for both. If the company harvests wood from only one property, stumpage, logging, woodyard, and transportation costs (S_t) will be multiplied by the probability of occurrence (in this case .5). Therefore, to determine the *PPVC*, equation (*1*) was modified as follows:

$$PPVC = I_o + \sum_{t=0}^{n} \frac{C_t}{(1 + r)^t} + P \left[\sum_{t=0}^{n} \frac{S_t}{(1 + r)^t} \right] \quad (2)$$

where:

P = probability of harvest such that $(0 \leq p \leq 1)$.

To determine the *PPVC* per unit of wood that is expected to be harvested, equation (*2*) is divided by the probable yield per acre.

A determination of the probability of procurement is crucial to this analysis. Research is needed to determine realistic values of P under various procurement scenarios. It is estimated that for company-owned lands P is very high. e.g., .98. The probability of procurement from leased land is only slightly less than from fee land to reflect the fact that occasionally a lease is broken. A well managed LAA program probably can experience procurement rates of at least .70 if the prevailing market price is offered for the timber.[2] The probability of procurement in the open market at competitive market prices should be approximately equal to the average proportion of all open-market wood typically procured by a given company.

DEMONSTRATION OF THE PPVC METHOD

A simple example will help demonstrate how the probable present value method is applied to capital cost budgeting for wood procurement. Consider a company that purchases southern pine pulpwood for the manufacture of paper products. The company faces the task of allocating limited capital among four wood procurement options.

Table 2 presents data on the four options. All cost data are presented in 1983 dollars, and it is assumed that the company's real (after inflation) rate of discount is 3%. It is also assumed, to simplify the analysis, that each tract of land has the same acreage and yield, and that each is equidistant from the mill. The following are discussions of each option:

Option 1—Management of a company-owned tract:
This tract will be planted in loblolly pine at a cost of $150 per acre to the company. Every year until harvest the company will pay $5 per acre for management costs and $12 per acre for landholding ($2 per acre for taxes, plus $10 per acre for the cost of capital). The probability of procurement is .98.

Option 2—Leased land:
This tract will be planted in loblolly pine at a cost of $150 per acre to the company, and the company will pay $5 per year to the landowner for the timber lease. The probability of procurement is .95.

Option 3—Landowner assistance agreement:
The company will provide loblolly pine seedlings free to the owner at a cost of $7 per acre. Annual management costs to the company will be $.50 per acre. The company will pay $15 per cord at harvest, and procurement costs are $1 per cord The probability of procurement is .70.

Option 4—Open-market procurement:
The company incurs no cost until the time of procurement. It is assumed that the cost of open-market procurement is $3 per cord. The probability of procurement is .30, which is the average proportion of open-market timber procured in that area by the company.

The *PPVC*'s are computed on a per cord basis (Table 2). For example, to compute the *PPVC* per cord for Option 1 the sum of the discounted values of the annual management and landholding costs is added to the reforestation cost. The transportation cost is multiplied by the number of miles and then discounted; this product is multiplied by the yield (40 cords) and then multiplied by the probability of procurement (.98). The logging cost is discounted and multiplied by the probability of procurement. The sum of all discounted costs is then divided by the probable yield (39.2 cords).

In this particular example, the company finds that the wood from the LAA program is cheapest. This is followed by wood obtained from leased land, from company-owned lands, and, finally, from open-market procurement.

BENCHMARK FOR DECISION MAKING

When using this capital budgeting technique, wood of a known price procured from one source, e g , open-market procurement, must be used as the

[2] Small Woodlot Forestry R & D Program, 1982. Unpublished.

Table 2. Description of the four wood procurement options and probable present value of costs (PPVC)[1] for wood to be harvested 25 years hence.

	Option 1 Company-owned lands (fee land)	*Option 2* Leased land	*Option 3* LAA program	*Option 4* Open Market
Mill distance (mi)	30	30	30	30
Acres	100	100	100	100
Rotation (yrs)	25	25	25	25
Yield (cd/ac)	40	40	40	40
Initial reforestation cost ($/ac)	150	150	7	0
Annual management cost ($/ac)	5	5	.50	0
Annual landholding or lease cost ($/ac)	12	5	0	0
Procurement cost ($/cd)[2]	0	0	1	3
Stumpage price ($/cd)[2]	0	0	15	15
Logging cost ($/cd)	35	35	35	35
Transportation cost ($/cd/mi)	.17	.17	.17	.17
Probability of procurement	.98	.95	.70	.30
Probable yield (cd/ac)[3]	39.2	38	28	12
PPVC per cord ($)[3]	30.96	27.94	27.58	31.09

[1] All cost data are fictitious.
[2] In the real world fee wood (wood from company-owned and leased lands) is not free. It is a cost to the procurement group and a revenue to the land group.
[3] All data are pretax; tax effects may be important but are not considered.

benchmark for determining whether wood obtainable from another source is cost efficient. If, for example, a company decides to continue managing its fee and lease lands but calculates that it will still suffer a supply shortfall, this capital budgeting technique may be employed to determine the least costly means of realizing its wood needs through a combination of landowner assistance and open-market procurement. In this case, the projected price of wood delivered to the mill under the open-market procurement system will serve as the benchmark for determining which properties to include under its landowner assistance program. Owners of nonindustrial private forest lands which provide wood at a lower cost than wood from the open-market procurement system would be encouraged to join the company's landowner assistance program.

Cost data for wood procured under a company's landowner assistance program from four NIPF ownerships are presented with the price of wood delivered to the mill under the open-market procurement system (Table 3). Results of surveys of company procurement personnel indicate that companies pay prevailing open-market stumpage rates for timber purchased from owners in their assistance programs.[3] Therefore, the best methods for decreasing the cost

[3] E. C. Franklin, 1983. Personal communication.

Table 3. Costs anticipated for five wood procurement alternatives.[1]

	Landowner 1	Landowner 2	Landowner 3	Landowner 4	Open-market procurement
Mill distance (mi)	5	35	35	35	35
Acres	100	100	100	100	100
Rotation (yrs)	40	40	40	40	40
Yield (cd/ac)	55	55	55	55	55
Probability of Procurement	.7	.7	.7	.7	.5
Probable yield (cd/ac)	38.5	38.5	38.5	38.5	27.5
Initial reforestation cost ($/ac)	1	1	1	10	0
Annual management cost ($/ac)	1	1	1	1	0
Procurement cost ($/cd)	1	1	1	1	2
Stumpage price ($/cd)	15	15	15	15	15
Logging cost ($/cd)	20	20	35	35	35
Transportation cost ($/cd/mi)	.50	.50	.50	.50	.50
PPVC per cord[2] ($)	12.58	17.18	21.78	22.02	21.92

[1] All cost data are fictitious.
[2] Real rate of discount: 3 percent.

of delivered wood from owners in assistance programs are to:

(1) reduce logging costs by assisting owners whose lands offer good logging opportunities;
(2) reduce hauling distance by assisting owners near the mill;
(3) minimize costs of assistance.

In this example, data for Landowner 2 are identical to data for Landowner 1, except that the distance to the mill is greater. Landowner 3 is identical to Landowner 2 except that logging costs are higher due to rougher terrain. Landowner 4 is identical to Landowner 3 except that the company agrees to provide the landowner with seedlings in addition to reforestation advice. Costs for wood obtained through the open-market procurement system are identical to costs for Landowner 4, except that procurement costs are greater and the probability of procurement is smaller. If wood obtained through the open-market procurement system is to serve as the benchmark by which to judge the cost efficiency of the other investment options, then, in this example, Landowner 1, Landowner 2, and Landowner 3 will be encouraged to join the company's landowner assistance program. Any additional wood needed will be obtained from the open market. The company will not choose to work with Landowner 4, because wood will be more costly than wood obtained from the open market.

USING THE PPVC METHOD FOR CAPITAL BUDGETING

The PPVC method has been computerized for capital budgeting applications. FILAE (Forest Industry Landowner Assistance Evaluator) is a user-friendly computer program which can be used to compare different investment alternatives and thereby determine which alternative will secure the needed timber supply at the least cost.

To use FILAE for any given tract, the user enters only those costs which the company will bear, including management costs, procurement costs, logging costs, woodyard costs, transportation costs, land taxes, stumpage prices, and a probability of procuring the wood. Based on this information plus discount and inflation rates, and the timing of receipt of a specified volume of wood, FILAE calculates the probable present value of costs per unit of wood delivered to the mill. Then, by comparing the costs of securing a given volume of wood from various alternative investment schemes, the user can select those alternatives that provide the needed volume of wood at the appropriate time, at the least cost.

For example, FILAE was run for a number of stands including NIPF's, fee and leased land, and open-market wood (Table 4). For the sake of simplicity, it is assumed that the only product produced is pine sawtimber. To meet a specific wood supply goal in a given year, all of the investment alternatives can be ranked. Alternatives with the lowest cost can be selected until the supply quota is reached. For example, suppose that corporate planners determined that the mill will require 110 MMBF in year 20, 115 MMBF in year 30, and 130 MMBF in year 40. The goal is to acquire the specified volume of wood at the time it is needed and at least cost.

To acquire the 110 MMBF needed in year 20, one would look at only those stands which will be harvestable in year 20 (Table 4). There are six stands: LAA 5, LAA 7, LAA 8, Lease 1, Fee 1, and Fee 2 Using column 4, Probable Present Value of Costs per MBF, one would select those stands which yield the lowest cost per MBF: LAA 7 which will produce 30 MMBF at $82 per MBF, LAA 5 with 25 MMBF at

Table 4. FILAE output for various procurement options.[1]

1 Property name	3 Probable yield harvested	3 Year of harvest	4 Probable present value of costs	5 Probable present value of total costs
	MMBF		*$/MBF*	*M$*
LAA 1	15	30	50	750
LAA 2	20	40	35	700
LAA 3	18	40	40	720
LAA 4	15	30	60	900
LAA 5	25	20	85	2125
LAA 6	22	40	42	924
LAA 7	30	20	82	2460
LAA 8	25	20	100	2500
LAA 9	25	30	55	825
LAA 10	20	30	65	1300
Lease 1	20	20	90	1800
Lease 2	25	40	38	950
Lease 3	25	40	45	675
Lease 4	30	30	70	2100
Fee 1	25	20	95	2375
Fee 2	25	20	88	2200
Fee 3	20	30	80	1600
Fee 4	15	30	56	840
Fee 5	30	40	41	1230
Fee 6	30	40	49	1470
Open-market[2] procurement	No limit	20	93	—[3]
Open-market[2] procurement	No limit	30	66	—[3]
Open-market[2] procurement	No limit	40	44	—[3]

[1] All data are fictitious.
[2] In this example, it is assumed that the quantity demanded is within the limits in which the supply curve is perfectly elastic and the marginal cost per unit is constant.
[3] Total cost of open-market wood depends on the extent to which this option is exercised.

$85 per MBF, Fee 2 with 25 MMBF at $88 per MBF, and Lease 1 with 20 MMBF at $90 per MBF. By investing in these stands 100 MMBF has been acquired; but 110 MMBF is needed. Open-market procurement will provide the last 10 MMBF at a cost of $93 per MBF. Therefore, Fee 1 and LAA 8 will not be selected as an investment alternative. Rather, the last 10 MMBF will be acquired through open-market procurement.

FILAE can also help in determining budgetary requirements for securing specified volumes of wood. Using column 5 (Table 4), the total minimum budget necessary to secure the 110 MMBF is $9,515,000 at an average unit cost of $86.50 per MBF.

The same method is used to determine which stands to invest in to secure the needed 115 MMBF in year 30. There are seven stands that can be harvested in that year: LAA 1, LAA 4, LAA 9, LAA 10, Lease 4, Fee 3 and Fee 4. Those stands that return the needed volume of wood at the least cost are LAA 1, LAA 9, Fee 4, LAA 4, and LAA 10. These will provide 80 MMBF. The remaining 35 MMBF should be secured through open-market procurement because it is cheaper than investing in any other alternative.

CONCLUSIONS

A major goal of the wood-using industry is to adequately plan for needed volumes of wood at appropriate times and at minimum costs. The methodology and computer program discussed in this paper can aid greatly in evaluating investment opportunities in landowner assistance programs and be a useful tool in the capital budgeting process involved in wood procurement.

The FILAE computer program has the capacity to run realistic situations involving hundreds of tracts. The program requires no previous computer training, is written in Apple FORTRAN and designed to run on the Apple II+ microcomputer. There is a charge for this program. For more information contact: Gary Kronrad, Small Woodlot Forestry R&D Program, School of Forest Resources, North Carolina State University, 103 Enterprise Street, Raleigh, North Carolina 27607 (919) 737-3566.

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Selection Management in Southern Appalachian Hardwoods

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ABSTRACT. A woodland tract of southern Appalachian cove hardwoods and mixed oak has been managed under the selection system of silviculture since 1946. Simply cutting in all commercial diameter classes (i.e., 6.0 inches and larger), as was the practice during the first 24 years, failed to develop enough desirable saplings and poles to maintain the system. After 1970, herbicide treatment of undesirable, tolerant understory species in openings created by removal of large trees or groups of trees has improved the status of desirable saplings. Although long-term costs of management and yields are uncertain, the study suggests that creation of larger openings and treatment of undesirable understory species offers at least a chance for success with the selection system in southern Appalachian hardwoods.

Management of eastern hardwood forests by selection methods of silviculture has produced mixed results and a great deal of controversy. Arguments pro and con are a mixture of biologic and economic considerations that are not easily generalized. The selection system, however, seems to work best for species that are highly tolerant of shaded conditions and where profitable production of timber on a sustained basis is not the paramount aim of management. Despite these limitations, the appeal of the selection system is still great, particularly for the small, private woodland owner. Many such owners would like to be able to use the selection system even though it might produce less than ideal results from a timber-production standpoint.

Documented here is a sustained attempt to manage southern Appalachian hardwoods with the selection system. The study covers a sizable area with variable site conditions and species composition and, most important, a relatively long period of observation. The study points up particular problems with the