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THE ECONOMIC MANAGEMENT OF SOUTHERN PINE Assisted By The Personal Computer

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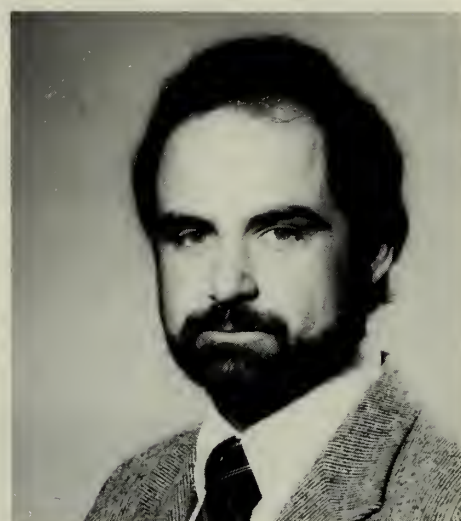
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DISCLAIMER

Mention of brand names or companies does not constitute an endorsement by the Georgia Forestry Commission or the State of Georgia.

This study describes the concepts and steps by which a forester may determine when a stand of timber is economically mature. The forester's traditional recommendation dictated a harvest when mean annual growth culminated. Economic performance was given little consideration in

the past, partly because the structure of stumpage prices and markets did not require it. More recently, when the market has been dictating a harvest schedule at variance with that indicated by volume growth alone, the forester is likely to have been overwhelmed by the complex-

ity of the required economic analysis. The availability of affordable personal computers and related decision-making software now enables the forester to cope with these complexities in devising a harvest schedule that is economically optimum for each unique stand of timber.

THE ECONOMIC MANAGEMENT OF SOUTHERN PINE

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INTRODUCTION

The question of when to harvest a stand of timber so as to maximize the owner's economic return has interested economists and foresters for generations. But only recently have practicing foresters come to recognize the economic aspect of the harvesting regime. On a majority of the land in Georgia and other southern states most pine management practices have remained unchanged since the establishment of forestry as a profession. Many forest managers and landowners are still intent upon growing large pine sawtimber to an age of 40 to 50 years, even though economics dictate otherwise.

Market conditions have changed and market trends are emerging that call for more intensive evaluation of harvesting alternatives and forest management practices.

Until as recently as five years ago only universities and major forest product companies had the computer capability to develop income-maximizing forest management procedures. Today the personal computer is bringing this high technology capability to midsize forest product companies and forestry consultants. Harvest scheduling, sometimes called income-optimization planning, is a computerized procedure of simulating the growth

and development of a stand of trees that has been subjected to a variety of harvesting methods, including various thinning intensities and final harvest at different ages. Forest landowners that have initiated this technology have found that the present value of their timber holdings can be increased by as much as \$100 to \$300 an acre. Considering that the cost of implementing this decision-making technology is only a fraction of this increased value, the economic benefit to the landowner is evident.

This study sets forth the basic ingredients and basic steps in developing a computer-aided harvest scheduling program.

METHODOLOGY

Two principal components combine to produce the economic values with which the total financial performance of a harvesting option may be judged. These are the forest stand's volume performance or physical growth and the price or market performance. Harvest scheduling permits the forest manager to simulate various growth and market conditions and to measure their joint impact upon the overall financial performance of the timber stand in each instance. It should be emphasized that contrary to earlier forest practices, it is not sufficient to measure the physical growth of the stand over time. In certain markets a 20 to 25 year rotation with no thinnings may produce the maximum income. In other markets a 40 to 45 year rotation with 1 or 2 thinnings may be required to maximize income.

The steps required for developing a harvest schedule or optimum income plan begin in the field, where volume data are collected by product class, species or species groups, site index, and forest type, e.g. natural or planted pine, or mixed pine-hardwood. Stand maps are then prepared so that trees of similar age, site quality, density, and so on are grouped in stands ranging from 20 to 70 acres in size or larger if conditions permit. After the field data are collected and the stand maps prepared the information is stored as a data base in the computer. Through programmed instructions, the data base file for each timber stand can be read and processed together with timber price information. The final computer output is a list of harvest possibilities together with their financial performances. Through this process various harvest alternatives can be reviewed and stored in computer memory for later retrieval and use. Literally hundreds of possible thinning and harvest combinations can be reviewed so as to determine those yielding the highest returns under various conditions.

VOLUME PERFORMANCE

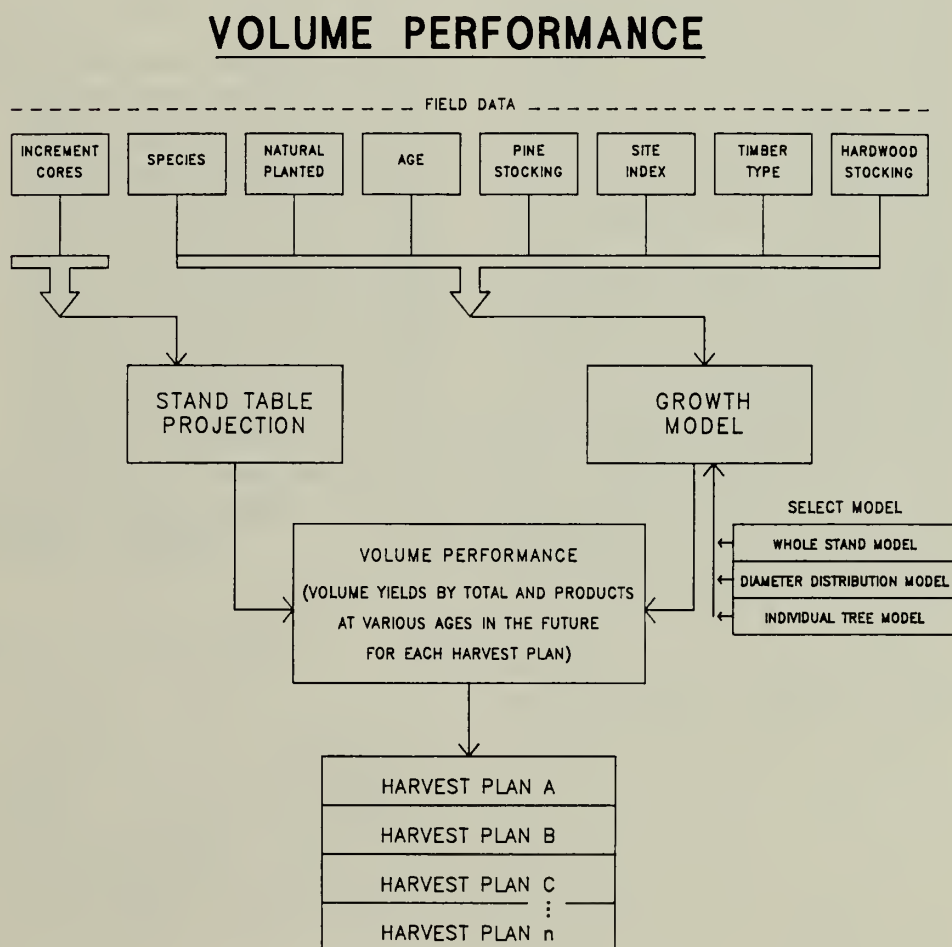
Volume performance is affected by the quality of land (site index), stand age, the amount of competing hardwood that is present in the stand, the density of stocking (basal area), species, and the origin of the stand, i.e. planted or natural stand. Most stand growth can be measured if these essentials are known. For years the stand table projection method was used to predict future volume. More reliable predictions of long term growth can be achieved from growth and yield models that are now available. Years of research have produced a number of published yield models for various southern pine species, both planted and natural. Using these models, biometricians have been able to

simulate stand growth over time. However, these models may require modification to fit particular stand circumstances and market conditions. Many models predict total volume for unthinned stands, which may be acceptable if pulpwood production is the sole objective. Other models predict total volume by diameter classes and thereby allow product separation based on size. A third type of model, developed through controlled forest inventory plots, predicts individual tree growth and growth by product classes from pulpwood to small and large sawtimber. While the subject of modeling growth is beyond the scope of this study, the choice and adaptation of the growth model has an important bearing upon the reliability of the harvest schedule and financial

performance.

The steps in estimating volume performance, together with the factors which influence that performance, are illustrated in Figure 1. The factors include the species of pine, whether planted or natural stand pine stocking, hardwood stocking, site index, and timber type. The steps in estimating volume performance may include the taking of increment cores from selected trees, for which the amount of growth for 5 to 10 years is recorded for use in a stand table projection. More appropriately, one of the available growth models may be selected as the means of estimating volume yields by product and stand age. By whatever method, it is generally accepted that the stand's rate of growth will decline with age

Figure 1



even though the total volume continues to increase, Figure 2 and 3. The total volume, measured in cords per acre, continues to increase to 45 or 50 years but at a decreasing rate. Beginning at age 20, total annual volume growth is seen to decline from more than 8 percent to less than 2 percent at age 50. Foresters from earlier generations would have the stand harvested at that age where the current annual growth rate of the stand drops below the mean annual growth. But the question of economic maturity for a stand of trees is more complicated than merely measuring volume growth.

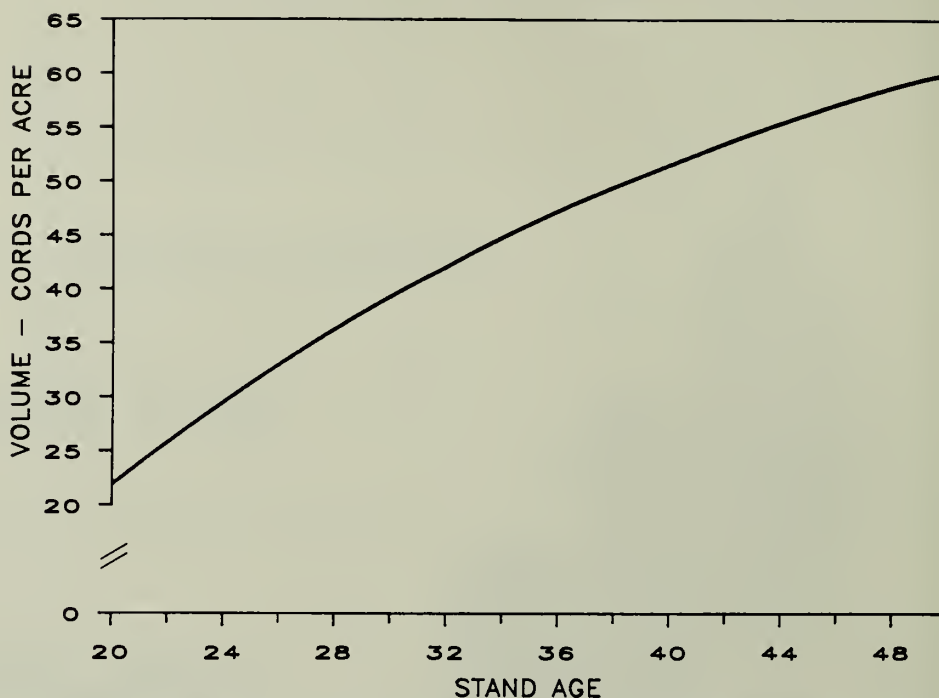
PRICE PERFORMANCE

Knowledge of price movements and price differentials can lead to entirely different management and harvesting practices than would be indicated by the stand's volume performance alone. The forester will be in a better position to advise the landowner on thinning practices and optimum harvest ages if he is aware of utilization technology, recognizes price differentials between various timber products, and has a basic understanding of inflation and the demand/supply conditions that affect timber prices. For example, if all timber products, including pulpwood, small, and large sawtimber, sold for \$30 a cord, it is obviously important to grow as much volume as possible regardless of tree size. With such a price structure, thinnings are unimportant because they do not increase and indeed may decrease total volume production and the optimum harvest age would be in the range of 22 to 25 years since this is the age at which volume growth reaches a peak on most sites in the southern pine region. In contrast, if pulpwood is \$10 a cord, small sawtimber is \$30 a cord, and large sawtimber \$80 a cord, the product objective should be sawtimber, thinnings may become important, and the rotation age will lengthen to 32 to 38 years.

General price inflation, as reflected by the Consumer Price Index, has little effect on harvest scheduling because all harvest schedules will be impacted the same by a proportionate price increase. However, if one or more of the timber products experience price rises at a rate in excess of general price inflation they can be said to exhibit "real" price appreciation. Real price appreciation is important to the harvest scheduling process if the various timber products appreciate at different rates, as has been the historical trend. Price performance is therefore determined by the volume growth movement from lower-priced to higher-priced products, such as from pulpwood to chip-n-saw and sawtimber, and sometimes by real price appreciation, as well, Figure 4.

Figure 2

VOLUME RELATIVE TO AGE



If timber is being scheduled for a three tier market, as above, it is important to follow the relationship between the product prices. The wider the price spread the more important the role of price in the scheduling process. Conversely, as the price spread between products narrows, the greater the influence of volume growth and the less price performance impacts on the choice of harvest age. As noted above, if the price spread is nil the volume performance of the stand controls the harvest age, Figure 5. As the three price tiers

spread from \$30/\$30/\$30 per cord to \$20/\$40/\$60 per cord and to \$10/\$30/\$80 per cord, the stand's average price per cord relative to age pivots upward from the horizontal and the optimum harvest age increases from the low 20s to the upper 20s and mid 30s.

FINANCIAL PERFORMANCE

The interaction of volume growth, price growth, real price appreciation, and variable market structures all combine to yield the total financial per-

Figure 4

PRICE PERFORMANCE

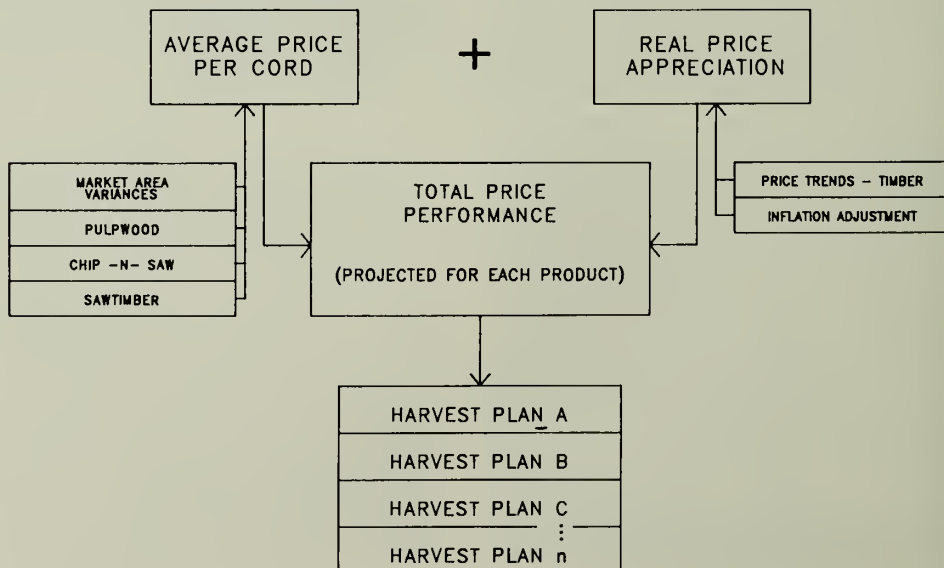
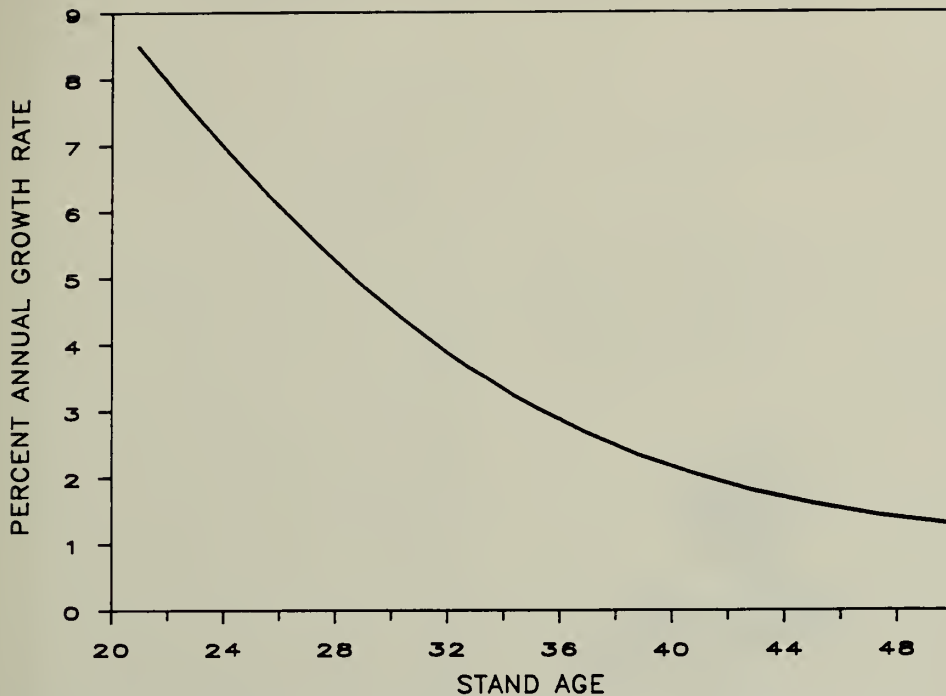


Figure 3

ANNUAL GROWTH RATE



formance of the stand, Figure 6. While the future stream of income can be projected with these variables, it is difficult to visualize the optimum harvest age unless the time value of money is recognized. This is accomplished by applying a discount rate to all future values, thereby reducing them to their present value. As this is done, a curve evolves that relates the present value per acre of the stand to the various stand ages, the peak of which indicates the financial maturity or optimum harvest age of the stand, Figure 7.

The selection of the discount rate is critical to the question of when to harvest a stand of trees in that this rate represents the opportunity cost of continuing the investment in the timber stand. Generally speaking, the lower the discount rate the longer the stand can be carried before it reaches financial maturity. Conversely, a high discount rate will tend to push the present value of the stand below the liquidation value of the present crop, indicating that other investments than timberland and forestry should be sought. While the question of the proper discount rate is beyond the scope of this study, it is important to note that if a market rate of interest is used for this purpose it should be adjusted for inflation, that is, expressed as a "real" rate of interest. Currently, most authorities on the subject recognize a real rate of interest for the economy in the range of 3 to 5 percent, annually compounded. A discount rate of 6 percent is used here because harvest scheduling

accounts only for timber and excludes the land investment, for which some authorities feel should be in the range of 5 to 7 percent. This will provide an overall rate of return on capital, including land and timber, of 3 to 4 percent. Finally, it should be noted that the internal rate of return method also is an acceptable measure of financial maturity. The present value method is used here because of its greater familiarity among foresters and some financial analysts.

FINDINGS

Using software developed by Forest Resource Consultants, Inc., this decision-making technology is illustrated by the example of a typical timber tract on which all field work has been performed, stands identified, and stand mapping completed, Figure 8. Stand No. 6 from this tract has been chosen for analysis. It is assumed to be a 40 acre plantation of loblolly pine that has reached the age of 20 in 1984 on land of average site quality. The current inventory of timber includes 6.2 cords of pine pulpwood, 9.9 cords of pine chip-n-saw, .8 cords of pine sawtimber, and .4 cords of hardwood sawtimber. The financial parameters of the analysis include the stumpage prices prevailing in the area, the annual per acre costs of ad valorem taxation and management, the per acre costs of site preparing and planting the stand which will replace the present one after its harvest, and the sales cost associated with thinnings and final harvest, Figure 9. In this illustration, pine timber thinnings, if any, are assumed to bring \$20 a cord regardless of tree size. At harvest the pine pulpwood, chip-n-saw, and sawtimber are assumed to bring \$20/cord, \$40/cord, and \$60/cord respectively, one of the three price tiers shown in Figure 5. Hardwood stumpage prices are seen to be \$3/cord and \$12/cord respectively for pulpwood and sawtimber. These are constant dollar prices and they are assumed to remain unchanged over the planning period, including the years into the next rotation. That is, a zero general price inflation rate is assumed and no real price appreciation is assumed for any of the

Figure 5

AVERAGE PRICE PER CORD RELATIVE TO AGE (CONSTANT DOLLAR)

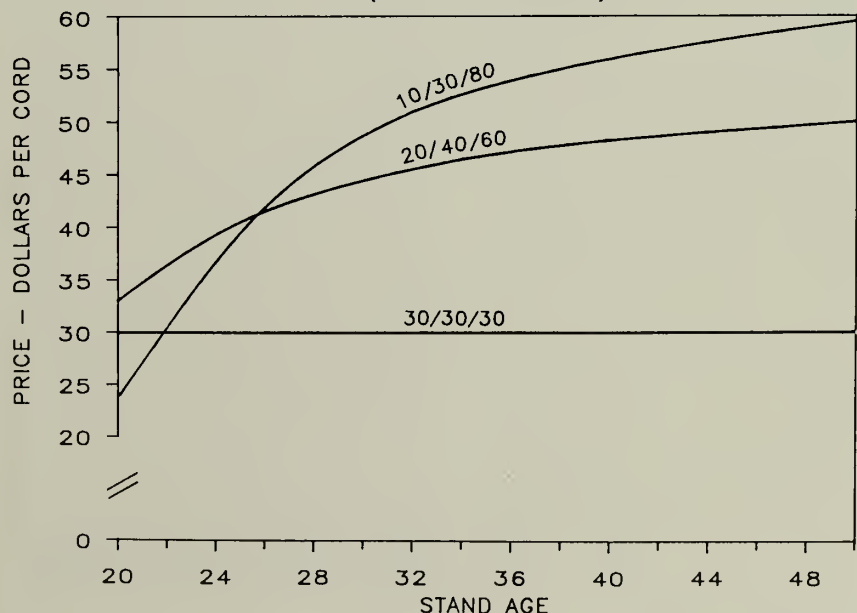


Figure 6

TOTAL FINANCIAL PERFORMANCE

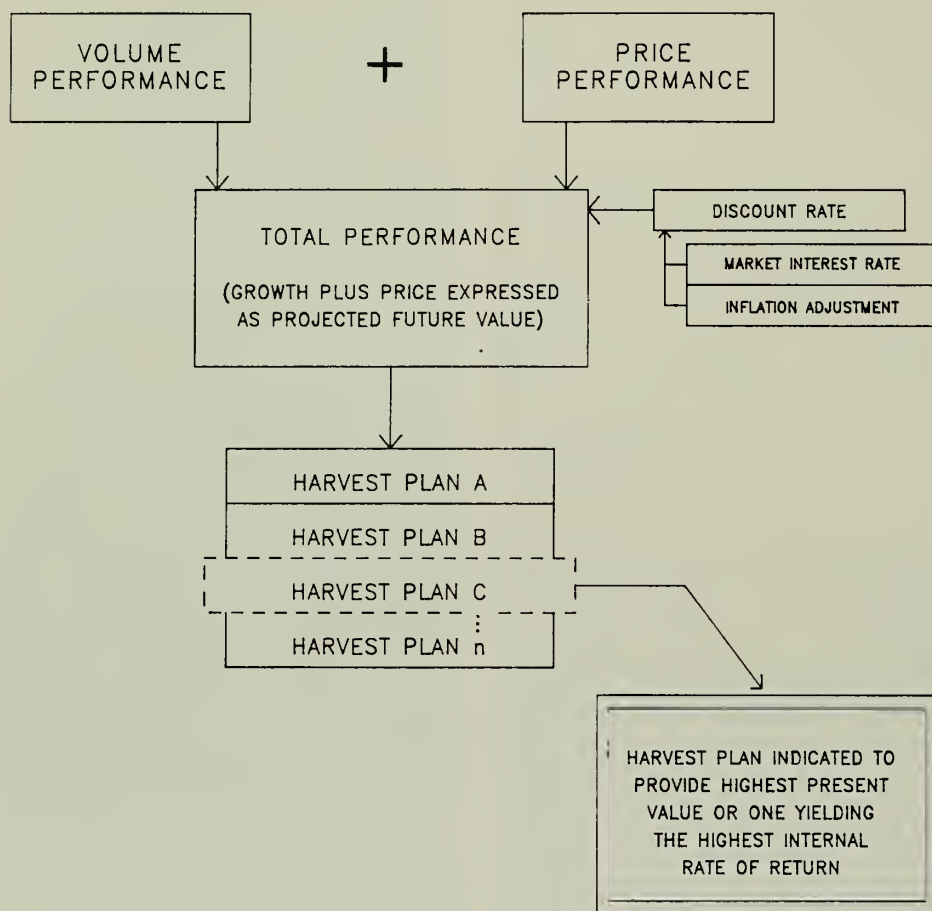
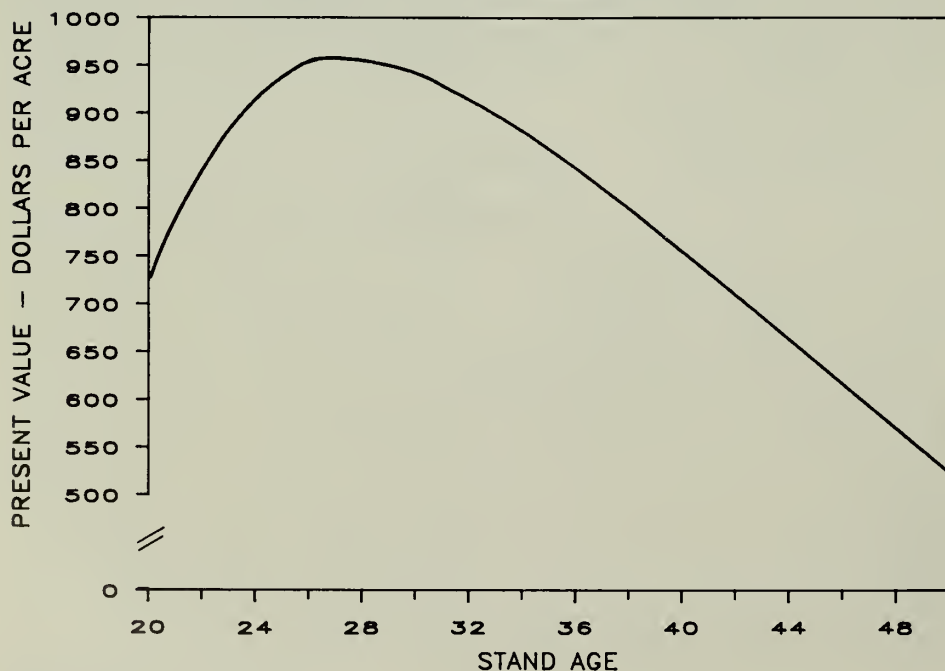


Figure 7

FINANCIAL MATURITY



products in this or the next timber rotation. The annual costs of carrying the present and succeeding stand, including taxation and miscellaneous costs, total \$6 an acre. Since this is currently a planted stand the cost of regeneration, i.e. the cost of establishing the replacement stand, is assumed to be only \$90 an acre. Finally it is seen that the discount or real interest rate is assumed to be 6 percent, annually compounded.

Financial maturity is seen to occur in 1992 for the example of Stand No. 6, when it has reached an age of 28 years. In deciding upon this harvest age, identified as Regime No. 90000, the computer will have considered many harvesting possibilities. These include the alternatives of harvesting the present stand at ages other than 28 years and subjecting it to one or more thinnings prior to harvest at various intensities. Importantly, the decision of when to harvest the existing stand will reflect the present value of the economic return that will be earned in the future on the plantation that is waiting to occupy the site of Stand No. 6, 2 years after it is harvested. It should be mentioned also that a timber stand as small as 40 acres may prove to be too small for mechanical harvesting and planting operations. In this event, it would be necessary to combine it with other stands in the tract to create an operating unit having the minimum acreage required for economical harvesting and planting operations. The resulting harvesting schedule for each stand as a part of that operating unit, therefore, will differ slightly from what would be optimum for the stand alone.

The indicated regime for Stand No. 6 includes no thinnings before harvest and projects a sales payout in 1992 which has a present value in 1984 of \$901 per acre, the maximum of any harvest year shown. As noted above, the net present value calculation incorporates the volume and price performance of the existing stand as well as that of the plantation stand that is waiting to occupy the site. Over the 9 years before harvest, the volume growth model projects that all product volumes, in total, will grow more than 75 percent on this stand. Furthermore, even though there is assumed to be no stumpage price increases for these products, the price performance of the stand until 1992 indicates a growth in value per cord of more than one third due to trees growing into larger and more valuable product sizes. During the period until 1992, this substantial growth in economic value of the existing stand is sufficiently large to offset the economic advantage of harvesting the stand and replacing it with the next pine plantation. For each year of possible harvest, the computer considers the economic advantage of carrying the existing stand another year without

TIMBER TYPE MAP

Tract J. Smith
 Land District Homeplace County, GA
 600 Total Acres 500 Wooded Acres

LEGEND

Primary Stream ———→
 Small Branch ... ———→
 Fence ———x———
 Woods Road ———=———
 Type Line ———-———
 Unit Boundary ———-———
 Iron Pin Found IPF
 Concrete Monument CM
 Utility Easement ———o———
 Gully ———~———
 Wet Area * * * *

COVER TYPES

Planted Pine PP
 Pine P
 Pine-Upland Hardwood PUH
 Upland Hardwood-Pine UHP
 Upland Hardwood UH
 Hardwood Branch HBR
 Hardwood Swamp HSW
 Beaver Pond BP
 Open 0

Stand Numbers

①

FIELD DATA

STAND NO. - 6
 STAND TYPE - Planted Pine
 SPECIES - Loblolly
 Age - 20
 Site - 80(50 yr basis)
 BASAL AREA - 73

CURRENT VOLUME(CORDS PER ACRE)

	Pine	Hardwood	Total
Pulpwood	6.2	0.0	6.2
C n S	9.9	0.0	9.9
Sawtimber	.8	.4	1.2
Total	16.9	.4	17.3

Figure 8



any treatment against the advantages of thinning the stand or harvesting the whole stand.

While 1992 is indicated to be the year of the stand's financial maturity, it is seen that the net present value of harvesting the stand in any of the calendar years from 1991 through 1994 or stand ages from 27 through 30 varies by less than one percent. This planning window allows the landowner a considerable period of leeway to accommodate personal cash flow needs and variable market conditions. Indeed, the creation of a harvesting schedule does not preclude the importance of recognizing market conditions or personal needs. Personal considerations may lead the land owner to desire a much earlier harvest than indicated even by the period of the planning window. In this event, the planning schedule indicates the economic return from forestry that he must sacrifice in order to indulge his need for an earlier cash flow. Also the planning window is a means of recognizing that no harvest schedule can be so precise as to predict the exact year of maximum economic payout. Finally, the plan must be revised periodically to consider unforeseen changes in market trends and other underlying parameters of the analysis. This emphasizes the importance of retaining a forester to monitor the management of timberland.

The revision of the harvest schedule

due to changes in underlying conditions is readily accomplished by the personal computer. For example, one of the arguable assumptions of this illustration concerns the structure of stumpage market prices that will prevail over the planning period. What if the market structure were to move from a \$20/\$40/\$60 a cord market for pulpwood, chip-n-saw, and sawtimber respectively to a \$30 per cord market for all products? As seen in Figure 5, if pulpwood is the sole market outlet, there is no price performance effect, i.e. increase in per cord value due to trees growing into larger sizes. At \$30 per cord for all products, the economic maturity of the stand occurs at an earlier year, 1987 as compared with 1992, and the planning window shifts. Also, the net present value of Stand No. 6 falls drastically from \$901 to \$658 per acre as it shifts to a pulpwood management regime. Conversely, if the spread of the three tier stumpage price market widens to \$10/\$30/\$80 and the average price per cord at harvest pivots upward as seen in Figure 5, the effect is to lengthen the rotation. The net present value of the stand also increases from \$901 to \$983. As seen with these "what if" examples, it is important for the forester to use an economic or financial criterion in determining when to harvest a stand of timber. The physical growth criterion alone is likely to result in a smaller

payoff for the landowner, by inducing him to plan for a harvest year that is too soon or too late.

SUMMARY AND CONCLUSIONS

The recent emergence of the personal computer has made available to foresters a high technology decision-making tool previously available only to large forest product companies. Although forestry software is in an early stage of development, it is believed that the transfer of this decision making technology to the nonindustrial timberland owner through his forester or financial advisor holds great promise for increasing the landowner's economic return from forestry. Further, considering that the southern pine forest is largely in the hands of nonindustrial landowners, the availability of affordable computer assisted forest management to this broad ownership class holds great promise for improving the productivity of the southern pine forest resource.

FIGURE 9

CLIENT: MR. J SMITH

TRACT: HOMEPLACE

OWNER: MR. J SMITH

STAND: NO. 6

FINANCIAL PARAMETERS

STUMPAGE VALUES (\$/CORD)

SPECIES	PRODUCT	EXISTING STAND		REGENERATED STAND			STUMPAGE	
		THINNING	HARVEST	THINNING		HARVEST	APPRECIATION RATES	
PINE	P/W	20.00	20.00	20.00	20.00	20.00	0.00%	
	CNS	20.00	40.00	20.00	40.00	40.00	0.00%	
	SWT	20.00	60.00	20.00	40.00	60.00	0.00%	INFL RATE 0.00%
HARDWOOD	P/W		3.00			3.00	0.00%	
	SWT		12.00			12.00	0.00%	DISC RATE 0.00%
SALES COST		SITE PREP & PLANTING:			AD VAL TAX: \$3.00		LEASE INC: \$0.00	
THINNINGS	10.00%	METHOD: BURN			MGMT FEE: \$2.00		MISC INC: \$0.00	
HARVEST	5.00%	COST (\$/AC)	\$90.00		MISC EXP: \$1.00			

OPTIMUM HARVEST REGIME FOR EACH HARVEST YEAR

				HARVEST YEAR	AGE	REGIME NUMBER	NPV @ 6%		
				1984	20	1000000	701		
				1985	21	2000000	752		
				1986	22	3000000	794		
				1987	23	4000000	828		
				1988	24	5000000	854		
				1989	25	6000000	875		
				1990	26	7000000	889		
FINANCIAL MATURITY	-->			1991	27	8000000	897	1.00% PLANNING WINDOW	
				1992	28	9000000	901		
				1993	29	10000000	900		
				1994	30	11000000	894		
				1995	31	12000000	886		
				1996	32	13000000	875		
				1997	33	14000000	861		
				1998	34	15000000	845		
				1999	35	16000000	827		
NUMBER: 9000000				2000	36	17000000	807		
00	0	00	0	2001	37	18000000	786		
				2002	38	19000000	764		
				2003	39	20000000	741		
				2004	40	21000000	717		
				2005	41	22000000	693		
				2006	42	23000000	669		
				2007	43	24000000	645		
				2008	44	25000000	620		
				2009	45	26000000	596		
				2010	46	27000000	572		
				2011	47	28000000	548		
				2012	48	29000000	525		
				2013	49	30000000	506		

1.00% PLANNING WINDOW

REGIME NUMBER: 9000000

9	00	0	00	0
H	2	I	1	I
A	N	N	S	N
R	D	T	T	
V		E	T	E
E	T	N	T	N
S	H	S	H	S
T	I	I	I	I
	N	T	N	T
Y		Y		Y
R	Y		Y	
	R		R	



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