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POTENTIAL CAPITAL INVESTMENTS FOR THE SOFTWOOD

BASED FOREST PRODUCTS INDUSTRY IN MAINE

presented by

John Elliott Houghton

has been accepted towards fulfillment
of the requirements for

Ph.D. degree in Forestry

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POTENTIAL CAPITAL INVESTMENTS FOR THE SOFTWOOD BASED FOREST PRODUCTS INDUSTRY IN MAINE

By

John Elliott Houghton

A DISSERTATION

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ABSTRACT

POTENTIAL CAPITAL INVESTMENTS FOR THE SOFTWOOD BASED
FOREST PRODUCTS INDUSTRY IN MAINE

By

John Elliott Houghton

Historically, management of the softwood forest of Maine has been extensive. Today, particularly on industrial ownerships, the extensive margin for softwood management is being approached or exceeded. This study evaluates a variety of intensive management alternatives.

Bio-technological alternatives are analyzed under various taxing methods. An internal rate of return analysis is utilized to evaluate cash flows resulting from intensive management activities incorporating the "allowable cut effect."

From the bio-technological point of view, the findings of the study suggest that the greatest economic potential for management intensification involves the silvicultural manipulation of naturally regenerated young stands of spruce and fir. Early entry into these stands is a significant factor in the economic returns that may result. Any variation of the socio-political tax constraint which relaxes the requirement that expenditures for artificial regeneration be capitalized results in significant improvement in the economic returns from such

investments. Although the returns under such circumstances are still below those of some of the treatments of naturally regenerated stands, the external benefits of species selection and stocking control become important considerations.

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CHAPTER I

INTRODUCTION

The historical management of the softwood forest of Maine has been extensive and oriented toward the husbanding of the resource. Today, particularly on industrial ownerships, the extensive margin for softwoods is being approached or exceeded. There is substantial concern as to where the intensive margin may fall and what activities may be undertaken to move toward that margin.

The objective of this study is to evaluate the economic potential of a variety of intensive management alternatives for industrial forest ownerships in Maine.

Feasible intensive forest management alternatives are evaluated both under current socio-political conditions and with variations in the socio-political tax constraint. A return-on-investment approach is utilized to evaluate cash flows resulting from intensive management activities incorporating the concept of the "allowable cut effect."

Perspective

In order to adequately assess the future softwood production/consumption picture for Maine's forest products industry and its relationship to capital investment, it is helpful to begin with a global view of the situation. Reviewing the world, national and state projections for softwood supply and demand (production and consumption) will help put the potential for capital investment into context.

Over the past several years, a number of organizations have estimated future world consumption of wood products. Although the absolute figures derived in these studies often differ, the relative figures are in basic agreement. On the consumption side, the future for manufacturers of wood fiber products looks good. Even conservative estimates of future consumption of paper and paperboard products show a doubling by the year 2000. To this can be added significant increases in the consumption of other wood fiber and resin based products, i.e., composites, fiberboard, plastics, etc.

Since the demand for wood fiber is a derived demand based on the demand for its end products, the above estimates indicate substantial increases in future wood fiber demand. It is generally agreed that the total world requirement for wood fiber will more than double by the year 2000. Canada's Western Forest Products Laboratory projects consumption of wood fiber for paper and paperboard to be in excess of 1.4 billion cubic meters, or approximately 49.4 billion cubic feet, by the year 2000, a figure that exceeds the total current world cut of industrial wood (13).

From the point of view of wood products producers, projections of the supply (production) of wood fiber in the future are not as encouraging. If consumption projections are correct, and price stability is maintained, shortages will occur. The most critical shortages are likely to be in softwood fiber. A recent report to the State of Maine indicates that FAO/EEC studies demonstrate the existence of an increasing gap between demand and supply of wood and wood fiber in Western Europe, beginning in 1970 (21). The result of this has been an increased drain on Scandinavian pulpwood and saw-timber supplies to the extent that the Scandinavian countries have recently become net importers of wood. At the same time, it appears that domestic consumption of the softwood resources in Eastern Europe and the U.S.S.R. is increasing. In short, world softwood "demand" (consumption) is becoming greater than "supply" (production) and the situation is likely to worsen (21).

A number of alternatives exist to reduce, if not avert, predicted world shortages of softwood. A limited amount of relief may be derived by substituting hardwoods for softwoods where technologically feasible. The greatest potential lies with more complete utilization of the fiberous material currently being harvested. Many estimates suggest that 40 - 60 percent of the total volume of fiber harvested annually remains in the woods (35), mainly because it does not meet current merchantability standards. Substantial technological development in harvesting and processing will be necessary to economically utilize this unused fiber. Another alternative for increasing future world supplies of fiber is the expanded use of recycled paper. A number of cost and environmental constraints currently limit the utilization of these resources to their fullest potential. Expanded research and technological development in this area will increase this potential.

Finally, it is anticipated that future fiber supplies will be expanded through the intensification of management on currently productive and unproductive forest lands. This intensified management would likely include a variety of capital investments and the utilization of genetically improved growing stock.

Projections of shortages of timber in the United States are not new to the forestry profession. The very foundation of professional forestry in our country came in response to concern over potential depletion of our timber resources. The now classic, "Copeland Report" in 1933, warned of overcutting and the potential for timber shortages (27). Again, in 1958, the U.S. Forest Service stated in Timber Resources for America's Future:

> If medium projected demands were met over the next two decades, important impacts on the timber resource would occur before the end of the century. Inventories and growth would decline sharply, timber cut would fall well below the level needed to supply projected demands, and there would be limitations in supply of important species and grades of timber. These impacts would be felt first and to the greatest degree in eastern softwoods,...(26, O. 495).

The U.S. Forest Service's 1974 review of the timber supply/demand situation concluded:

> Comparisons of these supply and demand projections indicate that under the economic and other conditions assumed in this analysis fairly substantial increases in prices of timber products relative to the general price level will be necessary to balance demands and available supplies of timber (25, p. 215).

The 1975 assessment of timber resources in conjunction with the Resource Planning Act included the projections of pulpwood demand shown in Table 1.

TABLE 1.--Low, medium and high projections of U.S. pulpwood demand

Year	Low	Medium	High
		(million cords)	
1980	111.8	117.9	125.9
1990	129.5	144.7	163.5
2000	147.5	172.6	207.4
2010	165.8	205.5	263.0
2020	178.9	232.6	316.0

Source: (23).

Projections of demand for roundwood for other products in that document also display significant increases. Thus, even at low projection levels, competition between uses is likely to increase and shortages will occur, particularly in the softwood sector. In addition, it is anticipated that political and environmental constraints will result in decreases in the land area available for timber production, primarily in the public sector. The end result will be increased demand and competition for timber from the private sector as well as increased demand on the remaining public lands available for timber production.

The answers to the problem of providing the supply to meet projected demand lie in the same programs mentioned in the previous discussion of world supply and demand. That is, improved utilization of the resource including all forms of waste, expanded use of recycled or reclaimed fiber, and increased productivity of forest lands through intensified management. In addition, it is suggested in the RPA Assessment that programs to increase the commercial productivity of nonindustrial private landholdings would contribute substantially to meeting future requirements for wood (23). Even then, most studies indicate that shortages will occur in certain segments of the timber economy at certain time periods. These, in turn, will result in increased raw material and product prices and commensurate economic adjustments in final product markets.

The Forests of Maine

The forest resources of the State of Maine are unique in several respects. The first of these may be seen in Table 2. With 90 percent of its total land area in forest, Maine leads the nation as to percentage of forest land area. It also has the largest area of commercial forest land as a percent of total land area (25).

The distribution of ownership of the commercial forest land area of the state is also unique. As can be seen in Table 3, 98 percent of this land is privately owned, the largest such percentage in the nation for states having commercial forest land areas in excess of 5 million acrea (25).

Even more unique is the concept of the "common and undivided interest" in the land. This is a system that developed out of the business and economic environment which existed during the period that Maine was settled. "So far as it is known, this system of

Table 2.--Area by land classes, Maine, 1971

Land Class	Area	
Forest land:	Million	Percent
Commercial	16.9	86
Productive-reserved	.2	1
Unproductive	.6	3
Total	17.7	90
Nonforest:		
Cropland	.9	4
Pasture	.1	1
Other	1.1	5
Total	2.0	10
Total Area	14.8	100

Source: (7).

Table 3.--Maine commercial forestland, by ownership class, 1971

Ownership Class	Area	
	Thousand Acres	Percent
National Forest	37.5	*
Other Federal	35.8	*
State	163.0	1
County & Municipal	75.2	1
Total Public	311.5	2
Forest Industry	8,255.0	49
Farm Owned	1,122.1	7
Miscellaneous Private:		
Individual	6,797.2	40
Corporate	408.5	2
Total Private	16,582.8	98
All Ownerships	16,894.3	100

Source: (7).

ownership is found nowhere else in the world" (33, p.4). Under this system, fractional interests in parcels of land were conveyed to private owners, but no physical boundaries were established:

> ...each owner held his personal common and undivided interest or share of the total. Gains and losses were shared according to each owner's interest in the township (33, p.4).

As these lands have passed from one generation to the next, the ownership has become even more fractional in nature. Over time, some of the undivided interests have been sold to forest industry and are included in that category in Table 3. However, many of these ownerships are still in the hands of individuals. The majority is managed by private land management organizations, primarily for timber production. Thus, an estimated 70 percent of the softwood producing commercial forest land in the state is currently managed primarily for timber production.

Table 4 depicts the structural characteristics of the forest in Maine. As shown in that table, there is approximately a 60-40 percent split between softwood and hardwood land area.

The dependence of Maine's forest industry upon the softwood component of its forest is significant. As seen in Table 5, in 1970, 67 percent of the total harvest and 71 percent of the sawtimber harvest were softwood species (7). By 1973, the most current date for the state of Maine, the softwood portion of the total harvest had risen to 71 percent (7) while the total harvest increased. Recent estimates indicate that the softwood harvest probably accounts for between 75 and 80 percent of the total timber

Table 4.--Maine commercial forest land, by forest types and ownership, 1971

Type	Ownership		
	All	Public	Private
	(thousand acres)		
Pine-hemlock	1,812.0	35.0	1,777.0
Spruce-fir	7,949.4	164.7	7,784.7
Oak-pine	185.4	10.0	175.4
Oak-hickory	252.9	-	252.9
Elm-ash-maple	1,714.2	9.7	1,704.5
Maple-beech-birch	3,561.3	65.5	3,495.8
Aspen-birch	1,419.1	26.6	1,392.5
All types	16,894.3	311.5	16,582.8

Source: (7).

Table 5.--Removals of growing stock and sawtimber on commercial forestland in Maine, by species, 1970 and 1973

Species	Growing Stock		Sawtimber 1/	
	1970	1973	1070	1973
	(million cubic ft)		(million board ft)	
Softwoods:				
White Pine	71.2	81.0	312.8	191.0
Spruce	84.9	96.6	261.8	159.8
Balsam Fir	63.1	71.8	145.5	88.8
Hemlock	30.5	34.7	107.8	65.8
No. White-Cedar	20.1	22.8	47.8	29.2
Other	5.4	6.2	2.3	1.4
Total	275.2	313.1	878.0	536.0
Hardwoods:				
Oak	14.8	14.1	51.3	32.4
Yellow Birch	19.2	18.3	63.0	39.8
Paper Birch	18.2	17.3	38.7	24.5
Sugar Maple	27.8	26.4	75.3	47.5
Sofe Maples	23.8	22.6	105.8	66.8
Beech	9.5	9.0	17.3	11.0
Ash	10.1	9.6	32.2	20.4
Aspen	3.9	3.7	12.7	8.0
Other	6.2	5.9	24.6	15.6
Total	133.5	126.9	421.0	266.0
All Species	408.7	440.0	1,299.0	802.0

1/ International ¼ inch rule.

Source: (7).

harvest in the state

The Softwood Resource

Because of the dependence of the forest industry of the state upon the softwood component, the remainder of this document will be devoted to that component. In particular, it will be devoted to the capital investment potential in the spruce and spruce/fir forest types, with attention to the pine types where applicable. The other softwood types are generally utilized and managed as adjuncts to the spruce, spruce/fir, and pine types as they naturally occur. In addition, a significant portion of the forest area of the state occurs as a mixed-wood complex of softwood and hardwood. In many cases, the hardwood is operated to facilitate the acquisition of the softwood component where it would otherwise not be economical to do so.

Table 6 displays the annual growth and removal data for the softwood sector in Maine. The data for both years indicate a substantial surplus of growth over removals in total and in the critical spruce and fir species. The 1970 actual harvest was 50 percent of growth for the softwood sector. The 1973 estimates indicate that this figure would have increased to about 56 percent. The figures for the spruce and fir components combined were 37 percent in 1970 and 41 percent in 1973. These figures should not, however, stimulate complacency amongst those dependent upon the

Table 6. -- Annual growth and removals from softwood growing stock in Maine, 1970 and 1973

Species	1970		1973	
	Growth	Removals	Growth	Removals
	(million cubic feet)			
White Pine	73.7	71.2	75.3	81.0
Spruce	207.0	84.9	211.5	96.6
Balsam Fir	197.0	63.1	201.2	71.8
Hemlock	51.6	30.5	52.7	34.7
No. White-cedar	16.9	20.1	17.2	22.8
Other	3.8	5.4	3.9	6.2
Total	550.0	275.2	561.8	313.10

Source: (7).

softwood forest for their fiber resources. A number of factors indicate that economic shortages will occur in the future. Specifically, the volume of merchantable softwood will become limited without significant increases in product price, decreases in product output, or both, or increases in merchantable wood fiber production.

It is important to recognize that softwood growth is made up of two components: accretion and ingrowth. Accretion is the additional volume added to trees of merchantable size. Ingrowth is the addition of volume resulting from trees becoming merchantable, e.g., the volume of those trees that become 5 inches dbh during the measurement period. Ingrowth accounted for 57 percent of the average annual gross growth of all species in Maine during the twelve year period from 1959 to 1971 (7). If ingrowth is compared to average net growth for the same period the figure is almost 80 percent (7).

> ...spruce and balsam fir (the two major species) show a high proportion of ingrowth as a result of recovery from the spruce budworm epidemic around 1920. Many young spruce and fir that seeded after this attack reached growing-stock size between 1959 and 1971 (7, p. 73).

As a result, the distribution of the growing stock of spruce and fir is as shown in Figures 1 and 2. The 5-7 inch diameter class contains 35 percent of the spruce growing stock volume, while 64 percent of that volume is in the 5-9 inch diameter classes. The figures for balsam fir are 41 percent and 74 percent respectively. Recognition of these conditions is even more critical when it is

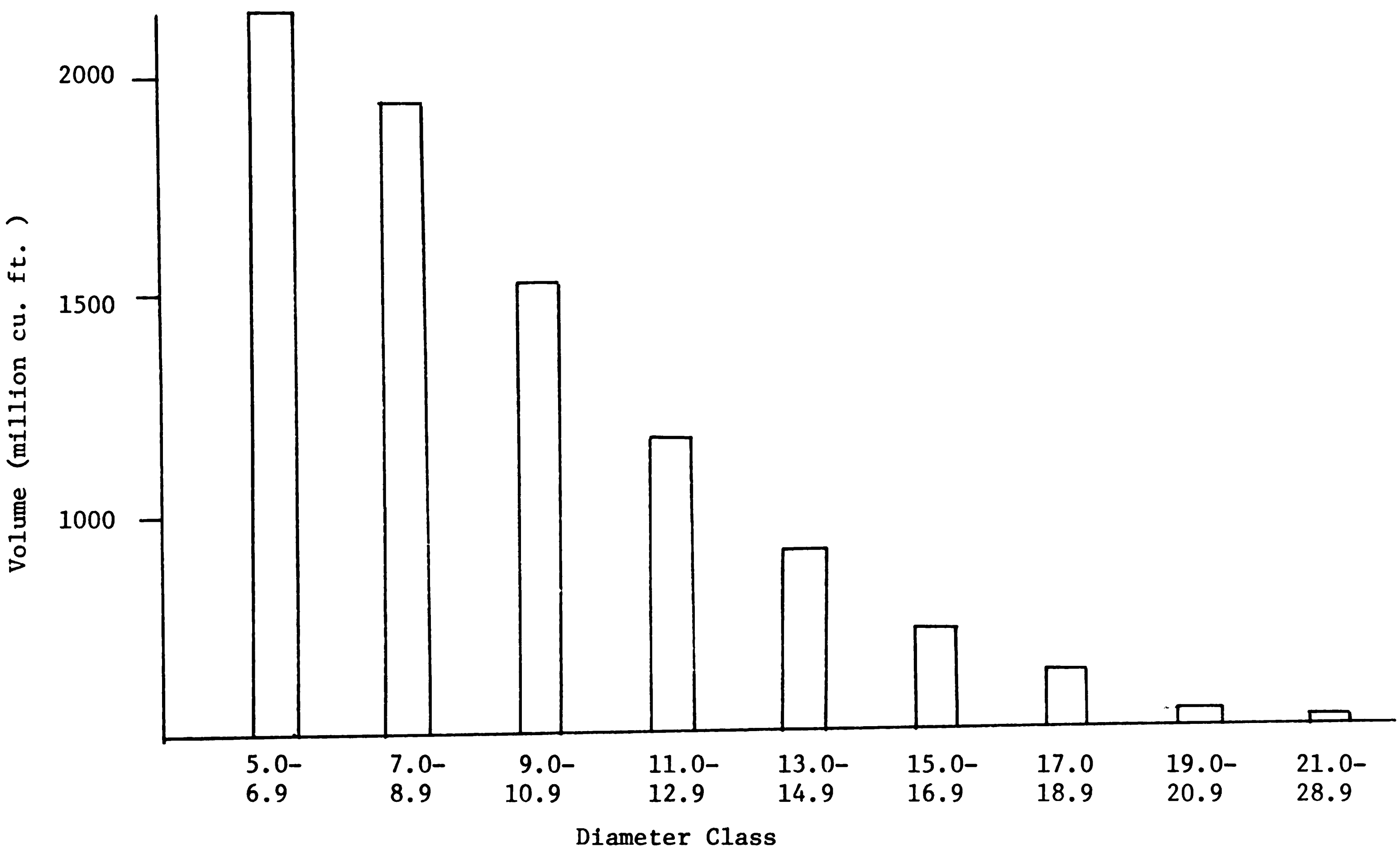

Figure 1. Distribution of spruce growing stock in Maine, by class, 1971

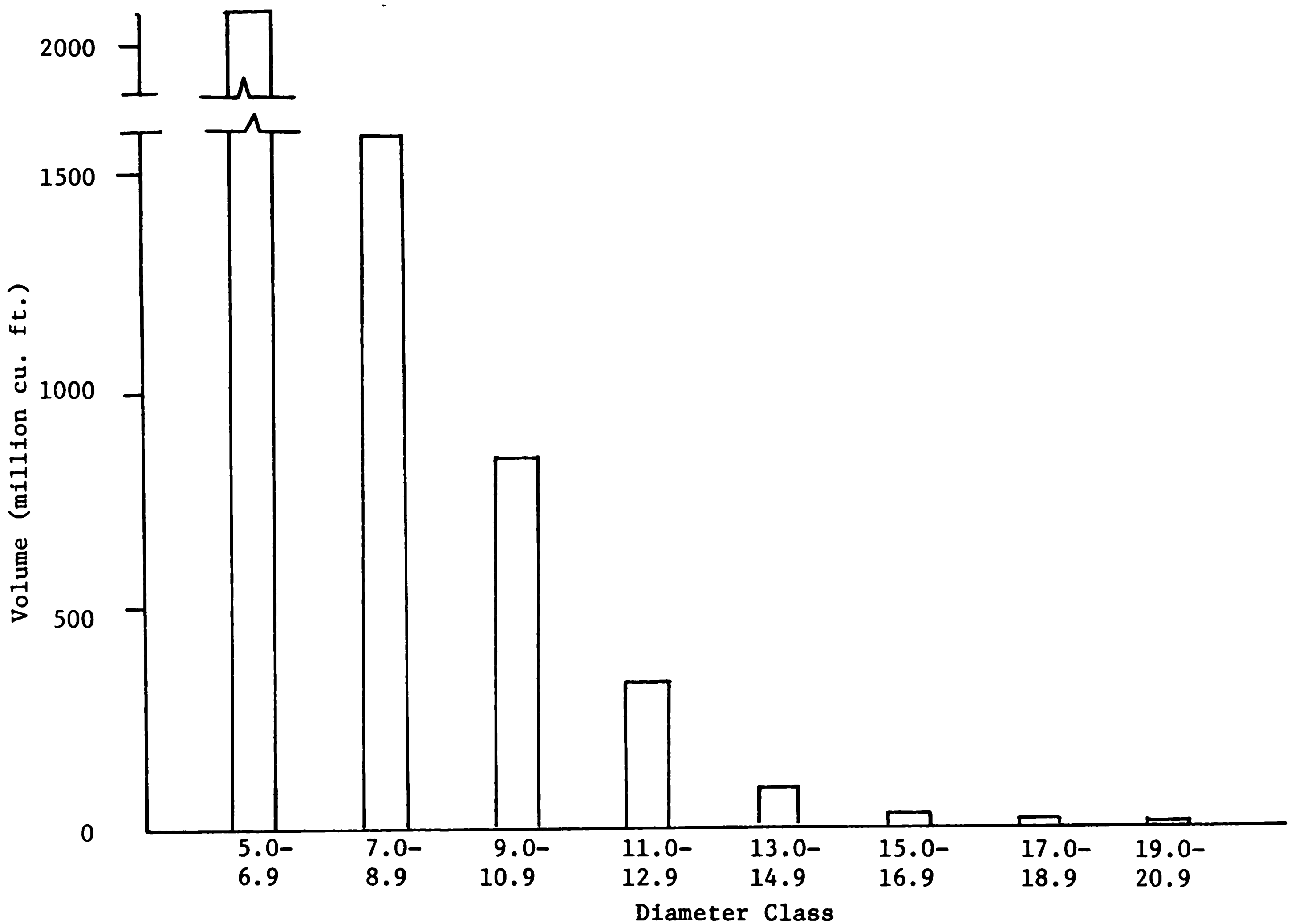

Figure 2. Distribution of balsam fir growing stock in Maine, by class, 1971
Source: (7).

realized that the spruce-fir forest type in Maine tends toward overstocking. Thus, as many of these stands reach the lower limit of 5 inches to be tallied as growing stock, they have become stagnated or are approaching that condition. The future growth due to accretion in these stands will be very slow.

The cost of harvesting operations in overstocked, small diameter stands, when coupled with the location factor, as reflected by transportation costs, makes many of these stands economically inoperable under current technology. Thus, although these stands are included in the determination of annual growth, they are not presently economically merchantable. Future stumpage price increases or technological change could alter this situation.

Small Ownerships

Another factor that must be considered, concerning the surplus of growth over removals from Maine's forest lands, is the impact of small private ownerships. Numerous studies have been done to evaluate small woodland owner attitudes toward timber management and harvesting. As a general rule, it has been found that the majority of nonindustrial private owners are hesitant to undertake investments in management intensification. Rather, they tend to harvest occasionally for periodic income (25). The reasons for this are usually involved with shorter time horizons and different goals of the individual owners, or economic constraints due to the smallness of the ownership. As previously mentioned, the nature of ownership interests in Maine has resulted in bringing much of the small ownership, nonindustrial land into timber production. None-the-less, it is estimated that approximately 30 percent of the commercial forest land in the state is not in active timber production, although the growth of timber of those acres is included in the annual growth calculation.

A consideration of the above factors led United States Forest Service researchers to conclude,

> Projections of future timber supply show that, if present removal trends continue, hardwood removals will exceed growth within a few years, and softwood removals will exceed growth before the turn of the century (7, p.2).

This conclusion was reached in 1972. Since that time, there have been major developments in three areas which underscore the above conlusion.

First, the spruce/fir forest of Maine is currently involved in the worst spruce budworm epidemic since the early 1900's. The seriousness of the situation is reflected in the passage of the "Maine Spruce Budworm Suppression Act" (2), and the development of one of the largest federal, state, and private aerial spray suppression efforts ever undertaken in the United States. In the preamble to the suppression legislation, it is stated,

> ...and scientists and foresters estimate that, without treatment, as much as 90 percent of the fir and 40 percent of the spruce within the infested area will die as a result of the infestation,...(2, p. 1131-1).

It is known that this infestation will substantially reduce the growth of the spruce and fir where mortality does not occur. The extent of growth reduction resulting from the infestation of in excess of 4,000,000 acres of spruce and fir forest is as yet unknown, but is expected to be large. These figures are not incorporated into the growth and removal information presented previously.

Second, substantial expansion has taken place in the forest products industry in Maine during the last few years. It is estimated that the productive capacity of the pulp and paper industry alone has increased by approximately 20 percent, much of this utilizing softwood fiber. According to the Paper Industry Information Office in Agusta, Maine, in the 1975-76 period alone, the paper industry expended in excess of $549.2 million for modernization and expansion of facilities in Maine. This consumption is also not reflected in the previous tables of growth and removals.

Also, as previously indicated, Scandinavian and Western European producers of pulp and paper are actively pursuing sources of fiber for import. Because of the similarity of the fiber characteristics of Maine' spruce and fir and the native Scandinavian species, it has been strongly suggested that a wood fiber export market will develop in Maine in the near future.

Finally, economic shortages of softwood timber may occur where physical shortages do not exist. This problem will not result from limited access to physical supplies, as is often the case. It will result from increased per cord costs of production, making some potentially usable wood uneconomical. The principal causes of the increased production costs are increased labor costs and decreased productivity resulting from the physical inability to operate in some stands. As is often the case, the result of these factors has been the mechanization of timber production by some producers.

There is little doubt that the combined impact of all of these factors will be periodic short-run, and potentially, permanent long-sun shortages in the production of softwood fiber in Maine, or price increases, particularly in the critical spruce/fir component. This realization has led to increased interest in the identification of the elements of the production function and potential changes that may be introduced to increase production of the critical softwoods.

Opportunities of Increased Production

In general, elements of the softwood production function fall into two broad categories: bio-technological and socio-political. In the bio-technological category, there are four major areas of concern:

1. Waste Reduction: Although there is a continuous effort to reduce the waste of merchantable fiber, both in harvesting and processing, some such waste still occurs. The primary source of this waste in Maine occurs in harvesting operations. Estimates of the volume of merchantable fiber remaining in the woods following harvest range from 10 percent to 15 percent. Conservatively,

if the 10 percent factor is used, the equivalent of 320.5 thousand cords of usable softwood and 172.4 thousand cords of usable spruce/fir fiber may be left in the woods annually. A 33 percent reduction of this waste would result in an additional 105.8 thousand cords of softwood and 56.9 thousand cords of spruce/fir fiber available to processing facilities annually, based on 1973 levels of harvest.

2. Improved Utilization: This category is distinguished from waste reduction in that it concerns potentially usuable wood fiber if technological change occurs in either harvesting or processing systems. To a degree, this is a function of species. The greatest potential is in the hardwood utilization area particularly as a source of energy. Nonetheless, it is estimated that no less than 30 percent of the softwood fiber and up to 65 percent of the softwood biomass remain in the woods following harvesting operations. Obviously, the utilization of this fiber is presently precluded by either technological or economic constraints. This will, however, become a valuable future source of wood fiber, should economic conditions dictate its development.

3. Land Base Expansion: This term may be misleading. It is not intended to imply an actual expansion of the commercial forest land base, but rather the development of programs to bring that commercial forest land that is not being used

for timber production into the productive status. One such program is the Forestry Incentives Program (FIP) administered by the United States Forest Service (24). Other programs of this type have been developed by forest industry in the West and South.

4. Improved Productivity: Within this category fall those programs designed to increase the merchantable volume of wood fiber produced on existing commercial forest lands. Generally reffered to as "intensified management," those programs include the capital investment involved in reduction of mortality, improved stand and stocking con- control, and improved growth potential.

Study Method

The analysis contained in the remaining section of this report provides an economic evaluation within the current socio-political context of the various alternatives for improving forest productivity. It will differ from most analyses of management intensification in that it is designed to evaluate these alternatives from the forest industry perspective.

A profit center approach is utilized in these analyses. That is, the alternatives are evaluated in the context of returns to the woodlands operation or investment. While the results may prove to be different if viewed in the context of the overall production process, through some measure like value added in manufacture, production techniques and outputs vary sufficiently between firms to preclude a generalized approach of that type. On an individual firm basis, the overal approach would be warranted and could be used as a comparative base with the profit center approach.

The economic evaluation is performed utilizing an analytical technique to determine the return on investment (ROI) resulting from alternative investments. The model employed is described in the following chapter.

The analysis recognizes that there are a variety of socio-political or institutional factors which influence the production function of any product. Management practices on public lands, public timber sales policiies, public regulation of activities on private lands, and tax policy are all examples of factors which would influence softwood production in general. Of these, federal tax policy regarding management practices is probably most critical to intensification of management in Maine.

The current federal policy regarding expenditures for reforestation is that such expenditures must be capitalized. In turn, capital gains treatment is allowed for harvested timber values.

> Generally, direct costs incurred in connection with reforestation by planting and artificial or natural seeding are capital expenditures, recoverable through the allowance for depletion when timber is cut ...Such planting or seeding costs include:
>
> (a) preparation of the site,...
> (b) cost of seed or seedlings; and
> (c) labor and tool expense, including depreciation of equipment...(28).

Thus, artificial regeneration, the most costly of the intensive management alternatives, carries the added burden of long-term capitalization, while other alternatives may not be so constrained.

CHAPTER II

ANALYTICAL APPROACH

The analytical technique employed in the analysis of bio-technological alternatives is the standard after tax return-on-investment approach generally utilized by the private sector in evaluating capital investments. It is recognized that the return-on-investment (internal rate of return) approach is but one of a variety of economic tools available to evaluate investment alternatives. It was utilized in this analysis because it is a measure that is commonly employed in the private sector and is considered to be economically valid where capital is the constraining factor. Competition for capital is a common constraint on industrial forest management expenditures.

Cash Flows

Unlike most capital investments that yield cash flows soon after an expenditure, many forestry investments do not show actual returns until some time into the future. Thus, the model was developed around the concept of the allowable cut effect (ACE) such that a stream of cash flows could be generated. The presumption in utilizing ACE is that future increases in yield, which will result from investments made today, may be utilized today, if there is sufficient merchantable volume to do so (18).

It is realized that the validity of ACE as a management tool has been questioned (18). One major concern is that an ACE generated increase in present harvest equal to the total additional volume that is estimated will result in the future as risky. However, the model employed here uses conservative estimates of possible increases and then uses equal annual increments of the increases over the life of the investment under consideration. In so doing, annual cash flows were created as in most other capital investment alternatives. In addition, as the life of an investment progresses, if estimated results were not being achieved, adjustments could be made to compensate, thereby reducing the risk. If, in the final analysis, the risk involved in utilizing ACE were considered limiting, the comparative standard of evaluation could be increased, requiring above normal returns from the investment under consideration.

The basic assumption of this analysis is that there is a cash flow savings to an industrial landowner if timber is cut from its own lands rather than purchased. Thus, any increase in yield resulting from intensified management would contribute to this "savings" of cash flow, in the following manner:

$$ACFI = SOP + NTS$$

$$SOP = IR - T_r$$

$$NTS = T_r - T_c + D_i$$

where: ACFI = Annual Cash Flow Increase

SOP = Savings in Out-of-Pocket Costs

NTS = Net Tax Savings

IR = Increased Revenue

T_r = Taxes (calculated at the regular rate)

T_c = Taxes (calculated at capital gains rate)

D_i = Depletion of Investment

Tax Savings

The following example shows how an industrial landowner would determine the after tax annual cash flow to be utilized in the ROI analysis. First, the merchantable volume and average annual yield for unmanaged stands must be determined for comparative purposes. Information provided by a number of industrial owners indicates that the average spruce/fir stand in which they operate yields approximately 25 cords per acre. The estimated age of these stands is approximately 60 years. Thus, the average annual merchantable yield is estimated at .4167 cords/acre/year. This figure provides the basis of comparison for potential investment.

Unless otherwise indicated, the following assumptions apply in this example and in subsequent analyses:

Regular tax rate	=	52%
Capital gains tax rate	=	30%
Fair market stumpage value	=	$10.00/cord
Depletion rate	=	$.20/cord

These assumptions are averages based on information provided by various industrial sources. It should be noted that depletion rate may vary substantially between landowners. The $.20/cord figure has been selected as a representative figure for the purposes of this investigation.

It is noteworthy, however, that the allowance for depletion of timber value is the means by which the capital value of the timber is recognized in this study. The forest area under consideration is assumed to be "dedicated forest" to the production agent performing the analysis. That is, while timber is not free, it is committed to the production program of that agent. Thus, the capital value of the timber, alone, is considered to be equal to its contribution to the depletion base.

For example, if an investment was made that increased the average annual yield by .5 cords/acre/year for 1,000 acres, an incremental increase in annual harvest of 500 cords per year, for the life of the investment, could result. The company could then replace 500 cords of purchased stumpage with 500 cords of company-owned stumpage, thereby increasing before tax revenues by an amount equal to the value of that wood. The after tax value of this 500 cords of purchased stumpage is equal to the purchase price less the tax payment, which is determined as follows:

500 cords	x	\$10.00/cord	=	\$5,000
				x 52% tax rate
				\$2,600 tax

\$5,000 - \$2,600 = \$2,400 savings in out-of-pocket cost

If the investment was undertaken there would be an out-of-pocket cash savings of \$2,400 in increased revenues less taxes.

The tax cash savings resulting from cutting 500 cords additional volume rather than purchasing 500 cords is represented by the difference between the tax savings from purchased wood and the tax cost of harvesting company-owned wood. Purchased wood is an operating cost and subject ot the normal tax rate while company-owned wood is subject to capital gains treatment. Thus, the net tax savings would be calculated as follows:

Purchased:				
500 cords	x	\$10.00/cord	=	\$5,000
				x 52% tax rate
				\$2,600 tax
Owned:				
500 cords	x	\$ 9.80/cord[1/]	=	\$4,900
				x 30% tax rate [2/]
				\$1,470 tax
Net tax savings:				\$1,130 net tax savings

[1/] Fair market value less depletion allowance. Depletion allowance is the means by which the initial capital value of a depletable resource is recovered by reducing the current market value at time of use.

[2/] Harvesting company-owned timber allows for capital gains tax treatment.

Therefore, the after-tax annual cash flow resulting from this investment would be:

Out-of-pocket cost savings	\$2,400
Net tax savings	1,130
Total savings	\$3,530

A simplified version of the foregoing financial or accounting approach to the determination of the savings in annual cash flow results in the same answer. The purchase of 500 cords of open market stumpage requires a cash outlay of \$5,000. The harvest of 500 cords of company-owned timber requires no additional cash outlay, but necessitates the payment of capital gains taxes on the value of that timber less the depletion allowance. From the previous calculations, the amount of the tax to be paid is \$1,470. Thus, the difference between the \$5,000 cash outlay for purchased stumpage and the \$1,470 capital gains tax on company-owned wood, must be the savings in cash flow. The difference is \$3,530. This figure would then be incorporated as the incremental annual cash flow in the ROI calculation.

The foregoing analytical approach has been utilized in the following evaluations of investment alternatives under existing socio-political conditions. As previously indicated, the assumptions as to stumpage value, tax rates, and depletion rate, will be the same as those on page unless specific changes are indicated.

The key element of federal tax policy that impacts on management intensification is the requirement that the costs of some such activities, particularly artificial regeneration, be capitalized for the purposes of tax computations. There are a variety of alternatives to the capitalization approach. To investigate these alternatives, the ROI calculation for a basic planting operation will be repeated to simulate the results under different conditions and provide the basis for evaluation of potential contribution to management intensification.

CHAPTER III

EVALUATION OF BIO-TECHNOLOGICAL ALTERNATIVES

Before embarking on an economic analysis of the silvicultural alternatives for intensified management, some digression to describe the silvical characteristics of the spruce/fir forest type is warranted. This assists in putting the various alternatives into context.

Spruce/Fir Silvics

One ecologic classification of the spruce/fir forests of eastern North America has broken them down into three major type groups: spruce/fir, spruce/fir-hardwood, and hardwood-spruce/fir, depending upon the relative presence of the spruce/fir component (32). Since the primary emphasis of this analysis is spruce/fir availability, it is noteworthy that the ability to regenerate spruce and fir in the above types has been determined to be "easy, moderately difficult, and difficult," respectively (32, p. 426).

Red spruce (Picea rubbens), black spruce (P. maiana), while spruce (P. glauca), and balsam fir (Abies balsamea) are the dominant softwood species of the spruce/fir forest types. Red spruce, black spruce and balsam fir predominate in Maine. A general comparison of the silvical characteristics of these species indicates some important differences. Balsam fir is a more prolific seeder than the spruces, tends to be more tolerant (although all are tolerant to very tolerant), and is generally considered to be a faster grower. However, balsam fir is also substantially shorter lived than the spruces and tends to be more susceptible to disease and insect attack, particularly spruce budworm, which, despite its name, prefers fir. This preference has led to severe damage to spruce, following initial attack of fir, where an infestation may otherwise have been much lighter. The various rot causing fungi which attack balsam fir not only result in substantial direct losses, but also result in making their hosts more susceptible to windthrow (8, 10, 11, 32). Despite this, the naturally regenerated spruce/fir forest in northern Maine tends towards over-stocking in the spruce/fir and spruce/fir-hardwood type groups. This has resulted in a sizable area of mature, small diameter, over-stocked natural stands.

This condition, combined with a consideration of the factors described in Chapter I, have led the forest industry and others in Maine to consider more intensive management alternatives of the spruce/fir forest. The following sections deal with a variety of these alternatives.

Artificial Regeneration

In general, the use of artificial regeneration serves one of two purposes: (1) to provide for adequate stocking of an area, where natural regeneration is or will be, inadequate; or (2) to create a stand of desired stocking level and species mix, where the natural stand may vary from that condition. In either case, the base genetic stock should be used to maximize the returns from the operation.

Artificial regeneration of the spruce/fir forest has received much greater attention in eastern Canada than in the mortheastern United States. For example, in the summary to the 1961 Biennial Report of the Maine Forest Commissioner, it is indicated that, during the 45 year period ending in 1959, 13,820 acres were planted. Of this, approximately 30 percent was planted to spruce (34). In comparison, it has been estimated that by 1965, in excess of 300,000 acres of white spruce artificial regeneration had taken place in Canada (22). In recent years, all sectors of the Canadian forest economy have expanded these efforts, with white spruce, black spruce and jack pine (*Pinus banksiana*) as the primary planting or seeding stock.

The artificial regeneration of the spruce/fir forest of northern Maine, primarily with white and black spruce seedlings, also has received increased attention. As a result of the expanded utilization of mechanical harvesting systems, growing interest in potential silvicultural gains, and potentially large salvage cuts in spruce budworm areas, forest industry, and others, have initiated programs of artificial regeneration. Containerized seedlings have been the primary planting stock.

The nature of the capital investment involved in maintaining a large scale program of artificial regeneration suggests that it must be undertaken by either public or large private interests. The distribution of ownership of Maine's spruce/fir forest suggests that industry will be the dominant interest in that area.

In recent years, Great Northern Paper Company, a division of Great Northern Nekoosa Corporation, has undertaken a program of containerized seedling production and artificial regeneration. This company reports that their program could be permanently expanded to supply material for an annual 1,500 acre planting.

Using the 1,500 acre per year planting level as a base, the number of ROI calculations were made under varying cost and harvest assumptions. To provide an incremental volume of which to base the calculations, it was necessary to establish estimates of merchantable yield for both natural and planted stands. Data presented in the Timber Resources of Maine suggests that the average natural stand of spruce/fir is about 60 years old and contains approximately 25 cords/acre of merchantable timber (7). White spruce plantation studies performed in eastern Canada suggest that such plantations, grown on moderate sites, would yield 53 cords/acre of merchantable volume in 45-year pulpwood rotations (22). A comparison of this informaiton is provided in Table 7.

Table 7.--Characteristics of spruce stands

Characteristic	Natural Stand	Planted Stand
Merchantable Yield	25 Cds/A	53 Cds/A
Rotation Length	60 Yrs.	45 Yrs.
Yield/A/Year	.4167	1.1765

Source: (7, 22).

Employing the ACE concept, the difference between the natural and planted stands is .76 cds/A/year, or 1,140 cords/year assuming a 1,500 acre/year planting program. This 1,140 cords/year provides the basis for determination of the increased revenues less taxes (stumpage cost savings) and net tax savings in the following tables. Under the assumption of a constant fair market stumpage value of $10 per cord, the stumpage cost savings and net tax savings are $5,472 and $2,576 respectively, for an annual cash flow of $8,048.

The costs of artificial regeneration programs vary significantly from site to site and species to species and by scale of operation. Applicable figures for the West or South do not apply in the Northeast. The most representative figures are those from the eastern Canadian provinces. One such figure indicated a total cost of $60 to $75 per acre, $20 to $25 per acre for site preparation, $20 to $25 per acre for seedlings and $20 to $25 per acre planting cost (19, pp.41-2).

Discussions with industry personnel and researchers at the University of Maine suggested that these figures are quite conservative for an operation of the scale being evaluated in Maine. While the site preparation costs were estimated to be similar, seedling costs were estimated to be much higher as were planting costs, since more costly manual labor is used in the planting phase. Thus, per acre costs used for the initial run were:

Seedlings	$ 50.00
Site Preparation	30.00
Planting	70.00
Total	$150.00

As is the case with almost all "cultural" operations, whether agricultural or silvicultural, the most costly component of a planting program is the most labor intensive component. In the case of reforestation in Maine, the planting phase is the most labor intensive. This results in a total cost of $225,000 for the 1,500 acre planting program. This amount is then carried for the life of the investment, in this case 45 years, when a portion of it is recoverable through the capital depletion allowance. In each of the intervening years, a cash flow is generated as previously described. In brief, the clash flow is generated as the sum of stumpage lost savings and tax savings. Using these data as inputs to the ROI calculation results in an overall ROI of 3.1 percent after taxes, as shown in Table 8. Referring to that table, the column headed "% ROI" shows figures beginning with .2 percent in the 29th year. From this it may be

Table 8.--ROI on planting at $150 per acre, 1,500 acres

Year	Capital depletion allowance	Added volume (cords)	Stumpage costs savings	Net tax savings	Cash flow	ROI (%)
1	-	1140	$5476	$2576	$8048	-
.						
.						
.						do
29						.2
30						.5
31						.7
32						.8
33						1.0
34						1.2
35						1.3
36						1.4
37						1.6
38	do	do	do	do	do	1.7
39						1.8
40						1.9
41						2.0
42						2.1
43						2.1
44						2.2
45	$225,000			$119,576		3.1

inferred that through the 28th year, the return on investment is negative, That is, the commulative cash flows are exceeded by plantation investment costs. Beginning with the 29th year, and throughout the remainder of the life of the investment, the stream of cash flows results in positive returns equivalent to those displayed. A significant jump in ROI occurs in the year 45, the harvest or rotation age because of the large tax saving resulting from the recovery of planting costs through utilization of the "depletion allowance."

Historically, where such conditions have existed, mechanical alternatives to manual labor have developed. Such has been the case of tree planting operations in other portions of the United States and Canada.

The major impediment to the mechanization of planting operations in Maine has been soil conditions. The soil tends to be extremely shallow and rocky over much of this territory.

In recent years, several prototype mechanical planters, capable of operating in adverse soil conditions, have been developed. Operational models of these machines are anticipated in the near future. A number of Canadian studies have reported costs of machine planting of conifers ranging from \$20 to \$80 per acre, based on a stocking of 1,000 seedlings per acre (22, p.131). The majority of these figures fall into the \$25 - \$45 per acre range. Using a figure of \$40 per acre for mechanized planting the overall cost of planting operations would be:

Seedlings	$ 50.00
Site Preparation	30.00
Planting	40.00
Total	$120.00/Acre

With mechanical planting, the toal investment for 1,500 acres would be reduced from $225,000 to $180,000. Under this condition, cash flows would be identical to those shown in Table 8 except for the year 45. The ROI becomes positive in year 22 for planting operations using the above cost assumptions and holding the other assumptions equal to those in the previous run. The new ROI by 5-year intervals is displayed in Table 9.

The previous analyses were premised upon the assumption of a constant stumpage value. Because of the inherent difficulties of projecting prices for the long time periods involved in forest management activities, this has been the accepted approach to such analyses. Based on historical data, it would appear that such an approach is justifiable, when considering pulpwood stumpage prices (9, 16, 17). However, stumpage prices for sawtimber have shown significant real increases.

> The increase in relative stumpage prices in the late 60's and early 70's is a continuation of the longrun trend...These longrun increases presumably reflect in large part the growing economic scarcity of timber (17, p. 7).

Table 9.--ROI on planting at $120 per acre, 1,500 acres

Year	ROI
	(percent)
1-22	-
25	.9
30	2.0
35	2.7
40	3.2
45 [1/]	4.1

[1/] In the year 45, the depletion allowance is $18,000 resulting in a net tax saving of $96,176 in that year.

Other work by the U. S. Forest Service indicates that long-term relative stumpage price increases have ranged from 3.2 percent to 3.5 percent annually since the early 1900's. It is estimated to average about 2.7 percent per year into the future (25, pp. 148-149). These figures relate primarily to western and southern species. It has been suggested that such increases would be somewhat lower for the Northeast, since the pulpwood component has displayed very little real increase in price over time (12).

In order to assessthe potential impacts of price increases in light of the above information, the previous runs were repeated using a two-percent per year increase in stumpage value. It was felt that such an increase was likely to be at the high end of what might occur, in reality, and would, thus, provide a mechanism by which the real situation may be bracketed. Tables 10 displays the ROIs under these assumptions.

In each of the previous analyses, the ROI after taxes was below 6 percent, varying from 3.1 percent to 5.7 percent. When viewed in the context of capital investment decision-making, alone, returns of that magnitude are insufficient to justify such large investments. A review of Tables 8 - 10 indicates clearly why such low ROI figures result. In each case, the incremental cash flow is so small that the discounted impact of its contribution is not substantial. Because of the current tax law which forces the capitalization of stand regeneration expenses until harvest, the sizable cash flow which occurs as a result of the capital depletion allowance on the original investment does not occur until the 45th year. When discounted, the impact of the cash flow is small. Thus, any activity which would decrease the period before harvest would result in improving the ROI for a given alternative.

There are two means by which the period before harvest could be decreased: (1) shorten the rotation, or (2) utilize some partial harvest earlier in the rotation. Research done in eastern Canada suggests that an overall reduction in rotation age for most sites below 45 years would not be practical under current standards of merchantability (22). However, commercially thinning the stand, at approximately 25 years of age, to a level that leaves a residual

Table 10.--ROI on planting at $150 and $120 per acre, with an annual 2 percent increase in stumpage value

Year	Planting Cost $150	Planting Cost $120
	(percent)	
20	-	.7
25	1.0	2.7
30	2.3	3.9
35	3.2	4.6
40	3.8	5.1
45	4.6	5.7

stand that is windfirm, has a twofold benefit. First, it constitutes a harvest cut which allows for depletion of a proportional amount of the original investment. Second, the residual stand is likely to respond to a release thinning in such a way that the final harvest level will equal (or exceed) the harvest level from a similar stand that is allowed to go through the full rotation without thinning.

The following tables depict the ROI results for runs incorporating commercial thinnings in the 35th which are assumed to yield 8.53 cords per acre, based on the periodic growth and yield data prepared for unmanaged white spruce plantations in Canada (22). The result of such a sommercial thinning of 1,500 acres would be an additional volume of 12,795 cords in the 25th year. In an effort to maintain consistency in the financial analysis and mitigate unusually large ACE increases, this volume was spread over the entire 45 year period of the investment by increasing the incremental annual harvest level to 1,424 cords. This then assumed on the physical side that the additional volume which would occur in the 25th year would be used to offset other harvests. This assumption has merit when considering the logistical aspects of harvest scheduling. In contrast, the additional 25th year volume could be used to offset additional purchased wood, thereby necessitating changes in the ROI calculations to reflect the financial impacts only in that year.

It has been suggested by some that the cost of such a thinning would be more than offset by the reduction of final harvest costs as a result of increased operability within the stands. Although this assumption may warrant further validation, it was incorporated into these analyses for the sake of simplicity. For the run displayed in Table 11, the cost of the planting operation was assumed to be $150 per acre and stumpage value was assumed to be constant at $10 per cord. Table 12 is a condenced display of a similar run assuming a two percent annual increase in stumpage value. Finally, Table 13 displays the results of runs assuming a commercial thinning, a two percent annual increase in stumpage values, and reduced costs of the planting operation to $120 per acre due to mechanical planting.

Table 11.--ROI on planting with a 25-year thinning, $150 per acre 1,500 acres

Selected years	Capital depletion allowance	Added volume (cords)	Stumpage cost savings	Net tax savings	Cash flow	ROI %
1	0	1,424	$6,835	$ 3,219	$10,054	-
.						
.						
.						
25	$112,500	1,424	6,835	61,719	68,551	2.2
30	0	1,424	6,835	3,219	10,054	3.0
35	0	1,424	6,835	3,219	10,054	3.5
40	0	1,424	6,835	3,219	10,054	3.9
45	112,500	1,424	6,835	61,719	68,554	4.4

Table 12.--ROI on planting with a 25-year thinning, $150 per acre, 1,500 acres and a two percent annual increase in stumpage value

Selected years	Capital depletion allowance	Added volume (cords)	Stumpage cost savings	Net tax savings	Cash flow	ROI %
20	0	1,424	$ 9,959	$ 4,650	$14,609	.7
25	$112,500	1,424	10,991	63,623	74,614	3.6
30	0	1,424	12,139	5,650	17,789	4.6
35	0	1,424	13,404	6,229	19,633	5.2
40	0	1,424	14,799	6,867	21,666	5.6
45	112,500	1,424	16,337	66,072	82,409	6.0

Table 13.--ROI on planting with 25th year thinning, $120 per acre, with and without stumpage price increase, 1,500 acres

Selected years	Stumpage price	
	Constant	Inc. 2% per year
20	.6	2.9
25	3.0	5.3
30	3.7	6.1
35	4.2	6.6
40	4.7	7.0
45	5.4	7.3

As can be seen, the resultant ROI's ranging from 4.4 percent to 7.3 percent represent an improvement over previous runs, but are hardly up to the 15 percent after tax level often used in the milieu of corporate investment analysis in the paper industry (1). In this context there exists, of course, the recurring question as to whether or not investments in silvicultural or forest management practices should be evaluated on the same basis as other corporate investments. This question is often linked with cost of capital considerations which are discussed later in this paper.

Any program of intensified management which utilizes artificial regeneration as a starting point, is, most likely, the most costly alternative. Where alternatives exist to utilize natural regeneration, they often prove to be more financially acceptable for the obvious reason that there is no additional capital invested in the regeneration itself. Cleaning and precommercial thinning are two such forms of timber stand improvement that should be evaluated in this context.

Cleaning

The term "cleaning" refers to a precommercial thinning performed in a stand of trees that has not grown beyond the sapling stage. It provides the manager with an alternative to planting that utilizes established natural regeneration as a starting point. Cleaning is considered to be particularly useful where naturally overstocked stands occur since, like planting, it reduces competition and concentrates merchantable fiber production on fewer stems per acre. Utilizing this technique, the manager is able to establish a stand of desired levels of stocking and species composition to the degree permitted by the natural regeneration and cleaning method employed. In his paper regarding cleaning in Northeastern softwood stands, L. O. Selin notes the following advantages of such practices:

> The main advantage is an increase in merchantable fibre production through the concentration of growth on fewer stems per acre. These remaining stems normally reach operable size sooner than their counterparts in natural stands and thereby make the shorter rotations possible. Other advantages are selection of species and selection of superior trees. If the rotation period of a stand is reduced from 65 to 45 years, and the volume of the cleaned or thinned stand at harvest time is equal to our present average volumes of natural stands, the growth increase over the shorter rotation period will be at least 30 percent. Also, in thinned stands, the volume per tree tends to be greater with less diameter variation. The cleaned or thinned stands are also in ideal condition for future silvicultural treatments such as fertilization. For a land owner with limited holdings and an interest in expansion, cleaning and precommercial thinning is a means of increasing the annual allowable cut immediately. The fact that future stands can be grown within a shorter time span will allow the present stands to be harvested over a shorter period and consequently at an increased volume per year. For those who must analyze the economic feasibility of alternative management practices on lands where harvest volumes are dependent upon the physical rate of growth of the forest, this effect, presently known as the allowable cut effect (ACE) offers an option not be be overlooked or taken lightly (19, pp. 31-32).

Another advantage shared by planted and thinned stands, over unmanaged natural stands, is reduced mortality due to natural factors, particularly spruce budworm. It is generally agreed that mortality from budworm is related to crown ratios. Since stocking levels in the managed stands are reduced, the crown ratios are increased. This, in turn, reduced risk of mortality by decreasing the potential for defoliation.

The typical cleaning operation would be undertaken approximately ten years into the growth cycle, or a period sufficient to allow for natural regeneration to become established. At that time, strips of the forest cover would be removed, leaving alternate strips of standing vegetation at desired spacing. The residual strips of vegetation would then be thinned, either mechanically or manually, to complete the operation and leave a residual stand of desired spacing. The utilization of manual labor in the second step of this thinning allows for greater selectivity as to species and superior phenotype. Research by L. O. Selin of Georgio-Pacific Corporation, and others indicates that totally mechanical operations have proven unsatisfactory to date.

> While our techniques have been improved, as we have progressed from purely manual thinning to a combination of mechanical strip clearing and hand thinning of residual strips, we have come to the realization that a complete mechanization of this work is nearly imposible (19, p. 33).

This does not completely preclude the potential for total mechanization in the future, however, particularly if stocking control is the major concern with liberal constraints as to residual stand composition.

The following analyses of potential cleaning operations employ the same format as was used in evaluating planting operations. It is important to note at this point that the alternatives being contrasted are the unmanaged natural stand with the cleaned natural stand. Research in this area indicates that the cleaned stand is capable of producing 45 cords per acre or more on a 45 year rotation (19). Thus, the incremental increase in yield for the analyses of cleaning has been estimated at .5 cord/acre/year on a 45 year rotation.

For comparative purposes, a cleaning program of 1500 acres has been assumed resulting in an ACE of 750 cords per year. Note that the life span of the investment is only 35 years, since the operation does not take place until the 10th year of the rotation. Also, the cost of the operation is treated as an expense, resulting in a substantial "tax savings" in the first year.

In the first example, Table 14, it was assumed that a combination of mechanical and manual labor would be employed in the operation. The cost, based on work by Selin (19), was estimated at $60 per acre and the stumpage values and tax assumptions were the same as previous runs. Table 15 displays the results for the same factors at 5 year intervals using an assumption of rising stumpage values.

As previously mentioned, the potential exists for increased mechanization of cleaning operations. It is estimated that such mechanization could decrease the cost to approximately $45 per acre.

Table 16 displays the results of ROI analyses which repeat the previous two runs assuming a cost of $45 per acre.

Table 14.--ROI on cleaning, $60 per acre, 1,500 acres

Selected years	Capital depletion allowance	Added volume (cords)	Stumpage cost savings	Net tax savings	Cash flow	ROI %
1	$90,000	750	$3,600	$48,495	$52,095	-
2	0			1,695	5,295	-
.						
.						
10						3.2
15						7.6
20	do	do	do	do	do	9.3
25						10.2
30						10.6
35						10.8

Table 15. -- ROI on cleaning, \$60 per acre, 2% annual increase in stumpage value, 1500 acres

Year	%ROI
10	4.6
15	9.2
20	11.0
25	11.9
30	12.3
35	12.6

Table 16. -- ROI on cleaning, \$45 per acre, with and without stumpage price increase

Year	Stumpage prices	
	Constant	2% annual increase
10	8.3	9.7
15	12.0	13.6
20	13.3	15.0
25	13.8	15.6
30	14.1	15.9
35	14.3	16.0

Initially, the results of the analyses of cleaning operations seem to be far superior to those of planting operations. The ROI's for comparable sets of activity assumptions, i.e., manual vs. manual, mechanized vs. mechanized, show returns for cleaning operations that more than double those of planting operations. However, in comparing the ROI for cleaning to the ROI for planting, it must be emphasized that the major difference lies in the more favorable tax treatment accorded the cleaning operation. Since the cost of the cleaning operation is not considered to be a cost of regeneration, as is the case for planting, it is "expensed" in the year of the operation. This results in significant cash flows early in the life of the investment, shortens the payback period, and results in positive returns on investment earlier in the life of the investment.

In all comparisons of the alternative forms of investment evaluated thus far, there are two other factors that must be considered. First, it is anticipated that the incremental returns from planting would be greater than those from cleaning operations and the control over stand composition far greater. Second, the initial investment for cleaning operations is substantially lower than that of planting and has a shorter life.

Precommercial Thinning

Precommercial thinning is distinguished from "cleaning" by the character of the stand at the time of the operation is undertaken. Precommercial thinning is applied to stands that have passed the sapling stage but have stagnated because of overstocking.

Precommercial thinning must be applied on a highly selective basis. The residual stand following such an operation must contain trees with sufficient crown characteristics to respond to the treatment. The stand must also contain trees of sufficient quality to warrant the investment. If these conditions exist, the return from such an investment is usually favorable.

The typical stand to which a precommercial thinning operation would be applied is 30- to 40-years old age class overstocked and contains little or no merchantable volume. A mechanical or combination of mechanical and manual thinning would be applied to create a residual stand of a desired stodking level to be carried to a rotation age of 60 years. It is estimated that such an operation would have a cost somewhat higher than a cleaning operation, due to the larger tree size of the initial stand, but probably not in excess of $70 per acre (19).

The following analysis employs the same format as previous analyses,with one major difference. It differs in that it compares what will occur in the thinned stand to what will occur if it were not thinned. It does not compare the thinned stand to the average natural stand as in previous analyses. It must be emphasized that a treatment of this type need only be applied to any given acre during the current rotation, since it is anticipated that in suceeding rotations the stand would be managed so as not to result in the overstocked condition that necessitates precommercial thinning.

In the following example, it is assumed that a precommercial thinning is applied to a 40 year old stand which will be harvested at age 60 (an investment with a 20 year duration). The estimated annual increment in merchantable volume is .67 cord per acre per year, based on silvicultural guides for spruce and fir and work by scientists at Georgia Pacific operations in Maine (10, 19). This estimate is recognized as conservative since it is possible that many untreated stands would yield no merchantable volume at age 60. The assumed treatment cost in this example is $70 per acre and an area of 1,500 acres treated was utilized for comparative purposes. Again, the cost of the operation is treated as an expense, resulting in a large initial "tax savings" and cash flow.

Table 17 displays the ROI, under the above assumptions, with an assumed stumpage value of $10 per cord. Table 18 shows the ROI analysis with an annual two percent increase in stumpage values. Like cleaning, precommercial thinning yields substantially better returns than planting, for much the same reasons. Once again, the tax treatment is different and the investment has a shorter life.

It should be emphasized that a change in merchantability standards to utilize smaller timber could preclude the consideration of precommercial thinning as a treatment. However, if this were to occur, the quality of the fiber produced in extremely dense,

Table 17.--ROI on planting with a 25-year thinning, $150 per acre, 1,500 acres

Year	Capital depletion allowance	Added volume (cords)	Stumpage cost savings	Net tax savings	Cash flow	ROI %
1	$105,000	1,000	$4,800	$56,860	$61,660	-
2	0			2,260	7,060	-
.						
.						
8						2.0
9						4.0
10						5.5
11						6.6
12						7.6
13	do	do	do	do	do	8.4
14						9.0
15						9.5
16						9.9
17						10.3
18						10.6
19						10.9
20						11.1

Table 18.--ROI for precommercial thinning, $70 per acre, stumpage prices increasing 2 percent per year

Year	% ROI
5	-
10	6.9
15	11.1
20	12.8

overstocked stands would become a major consideration.

Other Considerations

It is obvious that the number of alternative cost and/or price combinations, which could be incorporated into analyses such as the foregoing, are as infinite as man's imagination will allow. For, instance, it is entirely possible that the site preparation and planting phases could be combined into a single mechanical operation, further reducing the per acre cost of a planting program. In an attempt to maintain a conservative posture in the analysis, such potentialities were not investigated.

Regardless of the assumptions involved in the analysis, it would be fallacy to evaluate alternatives for intensive management exclusively on the basis of return on investment calculation of the type presented previously. There are some important cost and production considerations which have not been reflected in the analyses.

On the cost side, an important, but potentially overlooked benefit resulting from increased volumes incurred through intensive management is the reduction of the per unit road costs. That is, the larger the volume, the lower the road cost per unit of production.

A second cost reduction will be realized in harvesting costs. It has been estimated that the cost savings of harvesting operations under plantation or managed stand conditions would range from 20 - 40 percent, especially where mechanical harvesting techniques are employed.[1/] Since the future woods labor picture suggests a need for expanded mechanical harvesting practices, this becomes a particularly important consideration.

On the production side, there are important benefits to be realized by controlling stocking levels and species mex. By planting spruce at desired stocking levels it is anticipated that natural mortality due to breakage, blowdown, and insect attack will be reduced.

Finally, the stand conditions created by intensified management operations provide substantial flexibility for selective management of the forest. For example, in some of the previous analyses, the stands were assumed to be managed on a 45 year

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[1/] Estimates provided by woodlands department representatives of various industrial forestry operations in Maine.

pulpwood rotation with an intermediate commercial thinning in the 25th year. It is equally possible that the 45th year harvest could be a second commercial thinning with a final harvest in the 60th year, yielding an output of higher value sawlogs.

There are other alternative capital investments which appear to have potential and warrant further investigation, but currently lack sufficient data for this analysis. Fertilization, herbicide treatment, draining of high water table sites, and assistance to small landowners are investments of this type.

To date, fertilization studies in the spruce/fir forest types have proven to be inconclusive as to general applicability. That is, the growth response to fertilization has been highly variable. This type of treatment is dependent upon existing nutrient balances in the soil, which must be pre-determined if fertilizers of proper chemical composition are to be applied. Without such analyses, a general chemical application becomes a hit-and-miss proposition which may result in negative as well as positive responses.

There is little doubt that properly conceived programs of fertilizer application will yield significant benefits. The lack of adequate site specific response and cost data precludes operational investment analysis at this time.

The operational investment analysis of herbicide application is also limited by data deficiencies. Reduction of competition from various hardwood species will speed up stand establishment and, thereby, increase long-term productivity by shortening rotation length. It is also hypothesized that improved growth will occur as a result of reduced competition. However, the lack of sufficient physical response data and the lack of adequate operational cost data precludes further investment analysis.

Finally, it has been suggested that the spruce/fir resource base could be expanded through the use of small landowner assistance programs. The benefits of such programs are twofold: Economic supplies are increased by bringing formerly unmarketed timber into the marketing channel; and, through management, or other assistance, physical productivity may be expanded. The Forestry Incentives Program (FIP), administered through the U.S. Forest Service, has provided an impetus in this area. In recent years, the woodlands management programs of a few of the industrial forest landowners in the State of Maine have included programs of this type. While it is possible to develop estimates of the costs involved in such programs there has been little or no quantification of the results to date. Programs of small landowner assistance have proven to be at least moderately successful in the West and South. Since there is little doubt that the small landowner's share of the total supply of timber in the United States will need to be expanded (23, 25), such programs will receive greater attention in all areas in the future.

CHAPTER IV

SIMULATION OF TAX POLICY ALTERNATIVES

Forest industry representatives have argued that the capitalization requirement for artificial regeneration has created regional disparities in management intensification. On the average, the South and Far West enjoy a variety of natural factors that result in superior timber production capabilities. This in turn, results in a shorter capital recovery period than in Maine. This has resulted in a number of suggestions as to how the tax system may be changed to stimulate investment in artificial regeneration in other areas. While the tax system will not change regional differences in natural factors, it can have substantial impact on the economic considerations involved, particularly the timing of returns.

Potential alternatives have been applied to the ROI analysis of the basic planting program. That program entailed the planting of 1,500 acres, at a cost of $150 per acre, with an investment life of 45 years. To provide the proper perspective, it must be remembered that the ROI for the basic program was 3.1 percent with a payback period of 28 to 29 years.

The alternative to capitalization that would be most preferred by those in the industrial sector would be the consideration of regeneration costs as an annual expense. Table 19 displays the results of such an adjustment. By expensing the entire cost of the operation in the first year, a large after tax cash flow results. The large early cash flow shortens the payback period to 13 to 14 years with an after tax ROI of 6.6 percent at year 45.

While the industrial sector would favor the expense treatment of regeneration costs for tax purposes, such an idea has somewhat less appeal to the Internal Revenue Service. As an alternative, on occasion, it has been suggested that industry would be allowed to expense the costs of regeneration but, at the same time, relinquish the capital gains treatment for timber income. While such an alternative appears appealing, on the surface, from the perspective of the spruce/fir forest industry in Maine, it warrants further inspection. The following simulated example deviates from the ROI format, but helps to demonstrate the concern of many industrial landowners.

Assume the following case:

1. Company "A" owns 1,000,000 acres of spruce/fir forest land with an average net growth rate of .5 cd/A/yr.
2. Company "A" consumes 500,000 cords/year.
3. Spruce/fir stumpage value is $10.00/cord.
4. Depletion rate is $.20/cord.
5. Regular tax rate is 50 percent.
6. Capital gains tax rate is 30 percent.

Table 19.--ROI on planting program, planting costs expensed

Year	Capital depletion allowance	Added volume (cords)	Stumpage cost savings	Net tax savings	Cash flow	ROI %
1	$225,000	1,140	5,472	$119,576	$125,048	-
2				2,576	8,048	-
.						.
.						.
.						.
15						1.3
20	do	do	do	do	do	3.7
25						5.0
30						5.7
35						6.1
40						6.5
45						6.6

7. Planting costs are \$150/acre.

Given these data, the problem is to determine how many acres would have to be planted and expensed to compensate for the change in cash flow resulting from the loss of capital gains.

The taxes paid under capital gains treatment would be calculated as follows:

500,000 cords x \$9.80/cord x .50 = \$2,450,000.00

The tax cash outflow would be increased by \$980,000. Since the tax rate is 50 percent, an increase in annual expenses of \$1,960,000 would be required to offset the \$980,000 change in tax cash outflow. At \$150 per acre, a planting program would have to be in excess of 13,000 acres annually. That is more than 10 times the acreage currently being planted in the largest planting program in the state. Thus, a change in the tax structure of this type would result in the necessity for substantial capital investment in nursery facilities to supply intensified planting programs. Of course there would be a time lag associated with this development period, during which the industry would suffer a negative impact in cash flows due to increased tax cash outflows. Since investment capital that is devoted to these expansions would, in fact, eliminate investments in other, i.e., expanded production potential etc.

Another taxation approach that has received some attention is the concept of allowing an investment tax credit for reforestation expenditures. Returning to the ROI analysis format, Table 20 displays the results of such an approach with a 10 percent tax credit.

Table 20.--ROI on planting program with a 10 percent investment credit, 10-year amortization and a combination of both

Year	10% investment credit	10-year amortization	Inv. credit & 10-yr. amt.
25	-	3.8	5.0
30	1.2	4.4	5.6
35	1.9	4.8	5.9
40	2.5	5.0	6.2
45	3.6	5.3	6.3

The change in the ROI and payback period are only minor, by comparison. It is noteworthy that this run did not account for any change in the depletion base to compensate for the tax credit. If such an adjustment were made the ROI would fall from 3.6 percent to under 3.5 percent.

Amortization provides yet another alternative to capitalization which would allow for more rapid recovery of invested capital. While no specific guidelines exist for amortization of investments of this type, periods for most capital investments range from 3 to 20 years. Using a ten-year amortization results in an ROI of 5.3 percent (Table 20) with a payback period of 13 to 14 years. While the return is below that of the expense treatment, the capital recovery is the same. The lower return occurs because of the time dilution of cash flows that occurs over the period of amortization.

Results similar to those presented in the two previous analyses have led the Forest Industries Committee on Timber Valuation and Taxation to suggest that a combination of these approaches may provide the proper framework for taxation of artificial regeneration expenditures. Table 20 also displays in summary fashion the results of an ROI simulation combining a 10 percent investment tax credit and 10 year amortization of expenditures. The result is a payback period of 10 to 11 years and an ROI of 6.3 percent which approaches the 6.6 percent of the expense treatment. Again, the investment tax credit has not been deducted from the basis for amortization. The effect of this would cause a reduction in the ROI and extension of the payback period.

CHAPTER V

SUMMARY

Table 21 summarizes the results of the return on investment analyses of the various bio-technological variations in the production function. The alternatives investigated were divided into four major areas: planting, planting and thinning, cleaning, and precommercial thinning. In some cases the areas were subdivided by operational characteristics resulting in different cash flows, i.e., mechanical versus manual planting applications. In addition, each alternative was evaluated under two different stumpage value assumptions. First, stumpage values were assumed to remain constant in a relative sense. Then, evaluations were made utilizing a 2 percent year relative increase in stumpage values. It should be remembered that the 2 percent increase is considered to be an upper limit to what may occur since, historically, pulpwood stumpage values, unlike sawtimber values, have not displayed such high increases except in recent years.

The results of the analyses show after tax returns for the constant stumpage value alternatives ranging from a low of 3.1 percent to a high of 14.3 percent. With increasing stumpage values, the after tax returns varied from 4.6 percent to 16.0 percent.

Table 21.--Summary of returns to management alternative

Alternative	Per acre cost	Investment life	ROI	
			Constant	Increasing
		(years)	(percent)	
Planting:				
Manual	$150	45	3.1	4.6
Mechanical	120	45	4.1	5.7
Planting & Thinning:				
Manual	150	45	4.4	6.0
Mechanical	120	45	5.4	7.3
Cleaning:				
Hand & Machine	60	35	10.8	12.6
Mechanized	45	35	14.3	16.0
Precommercial thinning	70	20	11.1	12.8

The results of the various alternatives to the present method of taxation that were analyzed are summarized in Table 22. In each case, the basis for evaluation was an artificial regeneration program of 1,500 acres, costing $150 per acre, with the assumption of constant relative stumpage prices. This was the first alternative considered in the bio-technological evaluations. Since timing is critical to ROI calculations, a variation in tax treatment has a significant impact in cash flow, thus, a substantial impact on return on investment. The results were return levels varying from the basic 3.1 percent to 6.6 percent.

There are a number of factors that deserve comment and consideration before conclusions are drawn relative to these results. One factor that must be re-emphasized, is the site specific nature of operations involved. A fact sometimes overlooked by financial analysts is that a cleaning or thinning operation will result in a positive physical response only where competition for growing space exists and sufficient growth meterial remains after treatment. Similarly, planting sites must be evaluated as to site characteristics and conditions. As a result, the blanket application of any treatment or activity is seldom a viable alternative. What may appear to be a financially sound investment alternative may not prove to be physically attainable. Moreover, additional manpower and increased overhead costs may be required to identify potential sites for investment.

Still another factor that must be of concern is the general state of the economy, particularly capital markets. The big push

Table 22. -- Simulation results of alternative institutional approaches to taxation

Alternative	ROI (%)	Payback period (yrs)
Capitalization	3.1	28-29
10% Investment tax credit:		
No change in depletion base	3.6	25-26
Change in depletion base	3.5	25-26
20% Investment tax credit:		
No change in depletion base	4.1	22-23
Change in depletion base	4.0	22-23
45-yr. Amortization	3.9	21-22
10-yr. Amortization	5.3	13-14
10% Investment tax credit & 10-yr. amortization	6.3	10-11
Expensing of regeneration costs	6.6	13-14

toward the highly intensive "agro-forestry" commonly practiced in the South and West, arose during a period of relatively low capital market interest rates. When the prime rate reaches levels approaching or exceeding 10 percent, as it is now, capital intensive programs face heavy scrutiny.

In the recent past, intensification of forest management practices has led to expanded mechanization. There are hidden costs to mechanization that often require additional capital. Technical support, replacement parts inventories, and service and operator training programs are all costs associated with mechanization. In addition, the "pioneer" machinery is often quickly replaced by second and third generation machinery.

Another hidden cost of intensified forest practices is the management support system that is necessitated. Intensive management increases the demands on the resource and management professionals, often requiring additional manpower, and often results in the need for expanded and more complex management information systems.

Also, as capital costs increase, risk becomes an increasingly important factor. Long-term investments, such as those associated with forest management, are usually considered to be more risky than shorter term investments. When dealing with a biological entity, often a monocultural condition, the risk of failure due to an endless variety of natural causes is increased. The costs associated with these long-term risks are often underestimated. As the cost of capital increases, the risk factor tends to receive greater attention.

Finally, it must be remembered that the return on investment (internal rate of return) approach used in the foregoing analyses, like any other approach to investment analysis, has some inherent weaknesses. If one is attempting to rank investment alternatives, there are certain characteristics of this method that must be remembered. First, the solution to the rate of return calculation is a ratio which indicates nothing about the absolute size of the investments or returns involved. That is, a $50,000 investment and a $500,000 investment may both yield 10 percent returns on investment. However, they are vastly different investments and the impact of the returns on net worth are certainly different. Also, there are problems of scale and divisibility that must be remembered. That is, if a $500,000 investment yields 10 percent return, it seldom follows that a $50,000 investment will yield 10 percent. In forestry, scale economies often play an important role.

Another characteristic that must be remembered is the lack of time specificity in ROI calculations. Two different investments may both yield 10 percent returns, but have vastly different terms, i.e., 5 versus 15 years. Depending upon the objectives of the investor one would likely be considered superior to the other. In such instances, risk often becomes a critical factor. Finally, the general algorithm employed in solving ROI calculations presents an interesting problem. Where complex cash flows occur, there may be more than one rational solution to the question. In this event, there is the question of which solution to use. This could occur where combinations of intensive management applications are used, i.e., planting and subsequent herbicide treatment, or planting and thinning or any other combination.

Conclusions

Keeping in mind the factors enumerated in the preceding paragraphs and the foregoing analyses of investment and tax alternatives, it is now possible to draw some conclusions relative to intensification of management in the spruce/fir forest of Maine.

First, from the bio-technological point of view, the potential exists to make substantial gains by intensification of management. It would appear that the need for such gains will exist, either in domestic or foreign markets, or both, in the relative near future. The key will be the careful integration of various approaches to management intensification. Capital stringency will no doubt be pervasive and evaluation of risk will be critical. Silvicultural manipulation of natural stands should provide the foundation of the broad program with extreme care being exercised in the selection of sites for different applications.

Some of the alternatives investigated displayed improved returns under the assumption of mechanization of operations. There is little doubt that changes in the size, interests and attitudes of the labor force will necessitate such mechanization, again tempered by capital considerations. It is essential that this mechanization be developed with the general characteristics of the northern spruce/fir forest in mind. In general, the application of machinery developed for more general application has not been greatly successful in this area.

Cleaning and precommercial thinning operations hold substantial promise as alternatives to be included in a program of intensive management of the spruce/fir forest of Maine. Again, care must be exercised in the site selection and practical application since the growth potential and resistance to blowdown of the residual stands are keys to the physical success or failure of the operations, particularly in the case of precommercial thinning. Once these factors have been accounted for, the financial potential for such treatments appears to be sound. More favorable tax treatment and lower costs of operation result in shorter payback periods and higher returns on investment. The degree of control afforded by the implementation of these activities is less than that of artificial regeneration. However, these activities can be applied to existing stands, immediately. Thus, they may provide the valuable first step in the total program of maximizing the usuable fiber output of the spruce/fir forest of Maine.

Under prevailing socio-political conditions, unless highly superior genetic seed sources or budworm resistant strains are developed, planting should be employed only where natural regeneration is expected to be less than satisfactory. Planting entails the most costly approaches to intensive management and results in the longest term investment and payback period. If changes in tax policy were to occur, the role of artificial regeneration in Maine's spruce/fir forest may be changed.

The most preferable approach from the investor's perspective would be a shift in tax policy to allow for the treatment of planting and other currently capitalized costs as annual operating expenses. Political opposition to such a shift is particularly strong since it would cause a sizable change in federal tax revenues. Tax officials have, on occasion, considered a "trade" whereby planting and similar costs could be expensed but capital gains treatment for timber would be eliminated. In this context, it must be remembered that planting programs in the Northeast would have to be greatly expanded to reach an annual tax cash flow position similar to what currently exists under capital gains treatment. There is no firm in the Northeast that could accomplish such an expansion without considerable capital investment in greenhouse and/or nursery facilities and a significant period of time for transition to such a program.

Another alternative is some form of investment tax credit for intensive management activities. However, it is unlikely that this alone would provide sufficient stimulus for additional forestry investments due to the long time period required for investment payout.

The greatest potential for stimulating artificial regeneration investments via tax policy seems to be a 10-year amortization or combination of 10-year amortization and 10 percent tax credit approach. While the after tax ROI's for these methods are only

5.3 percent and 6.3 percent respectively, it must be remembered that expensing only results in a 6.6 percent ROI. The important point is that these approaches would substantially reduce the payback period on the investment while, at the same time, spread the impact on federal tax revenues over a period of years. Even then, it is doubtful that artificial regeneration should or will play as significant a role in intensive management in Maine as it has in other regions of the country.

The final conclusion to be drawn from this study relates to the need for continuing research in those areas related to the maximization of wood fiber from the spruce/fir forest. Primary emphasis should be placed on the further analysis of those activities considered in this document and improvement of the data base regarding forest fertilization and herbicide treatment of shrub and hardwood species. The extrapolation of physical response data is the key to the continued operational analysis of these treatments. This is not to indicate that other more esoteric approaches to management intensification should be ignored. Treatments of that type may very well provide the foundation for management programs of the future.

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