Financial Returns from Cultural Work in Natural Loblolly Pine Stands

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*ABSTRACT. Results of two large studies in North Carolina and Virginia show that volume growth of natural stands of loblolly pine (*Pinus taeda*) can be substantially increased through cultural practices. A corresponding increase in financial returns may also be expected if costs are reasonable and adequate markets are available. Control of competing hardwoods and precommercial thinning are keys to success. Control of large hardwoods alone doubled pine production and increased financial returns more than 200 percent. Additional treatments such as precommercial thinning and control of small hardwoods, tripled pine production above levels with no treatment and increased financial returns four to six times. The most dramatic increase occurred when the pine component of the stand was precommercially thinned and all hardwoods controlled at an early age. This more than doubled the financial returns from all the preceding steps.*

Financial analysis of a massive, long-term study in North Carolina and Virginia, shows that controlling large hardwoods can increase financial returns over 200 percent in natural loblolly stands. More intensive treatments yield even more dramatic increases in return on investment. These results are based on a range of costs and product prices which are clearly stated in this paper so that readers can identify specific situations.

When good management practices are followed, reliable results can be obtained by either artificial or natural means to regenerate loblolly pine. However, logistic and economic reasons dictate greater reliance on natural regeneration. This is particularly true on the 75 percent of commercial forestlands in small private ownership.

Only a small part of the forestlands harvested annually are artificially regenerated. Unless some cultural activity takes place following harvesting, most of these lands will revert to hardwoods or pine-hardwood stands. These stands are generally of low quality and value. Growth responses and financial returns from cultural treatments discussed here are based on 20-year results of two studies of the growth and yield effects of treating hardwoods and controlling density in young loblolly pine stands (Langdon and Trousdell 1974). These studies provide answers for previously unresolved questions regarding cultural practices.

Many landowners tend to consider natural regeneration free and are reluctant to invest in cultural treatments. However, cultural treatments will yield substantially greater rates of return than no treatment. While the final answers will depend largely on landowners' objectives, the results of these studies are encouraging and should motivate many landowners to initiate cultural work in natural loblolly pine stands. Cost-sharing programs such as the U.S.D.A. Forestry Incentive Program or one of the state programs available, can further improve the financial returns to individual landowners.

Our studies compared yields from ascending levels of cultural treatment of naturally regenerated loblolly pine on 90 areas in Virginia and North Carolina.

STUDY I: CONTROL OF LARGE HARDWOODS AND PRECOMMERCIAL THINNING TREATMENTS

Treatments

Treatments in the first study included prescribed burning before harvest (commercial clearcut), control of large hardwoods, and precommercial thinning. The levels of treatment were:

1. *Minimal:* control burned only, before harvest; no further treatments given. Hardwoods remaining after harvest were not treated.
2. *Intermediate:* Control burned before harvest; large hardwoods (5 inches d.b.h. and larger) controlled following harvest.
3. *Precommercially thinned:* In addition to level 2 treatments, pine was precommercially thinned at age six. Pine stems were reduced to approximately 9- by 9-foot spacing, and small hardwoods 1 inch d.b.h. and larger were cut.

These treatments were applied to 18 compartments of approximately 37 acres each. Each treatment was replicated six times. Thirty 1/10-acre measurement plots were established in each of the 18 compartments. This summary covers results based on 90 randomly selected plots from site index 95, five from each compartment.

Table 1. Merchantable cubic foot growth and yield of loblolly pine by stand treatments[1]

Stand treatment	Merchantable yields[2] Age in years 10	15	20	Growth MAI[3]
	Cubic feet			
(1) Hardwoods not controlled	10	290	848	42
(2) Large hardwoods controlled	70	782	1,776	88
(3) Pine precommercially thinned[4]	120	1,198	2,554	128

[1] *Source: Langdon and Trousdell.*
[2] *Trees 5 inches d.b.h. and larger.*
[3] *Mean Annual Increment.*
[4] *Includes control of small hardwoods 1" d.b.h. and larger.*

Growth Responses

Early treatments had a significant effect upon the yield of loblolly pine at ages 10, 15, and 20 (Table 1). Control of large hardwoods doubled pine yields at age 20. Precommercial thinning as well as control of large hardwoods tripled the yields of treatments in which the hardwoods were not controlled. Precommercial thinning, which included the cutting of small hardwood stems (1 inch d.b.h. and larger), showed a 44-percent yield increase over that obtained through control of large hardwoods only.

Growth of loblolly pine, expressed as mean annual increment (MAI) at 20 years, varied from 42 cubic feet for the unmanaged stand to 128 cubic feet per year for the most intensive cultural treatment in Study 1 (Table 1). At age 20, the MAI has not peaked and is still increasing. Although the number of merchantable pine stems (5 inches d.b.h. and larger) has increased, the number and proportion of merchantable stems are related to the intensity of practices (Table 2). At age 20, about 85 percent of the stems were merchantable in the stands treated by precommercial thinning; 60 percent were merchantable in the stands treated by controlling large hardwoods; but only 34 percent were merchantable in stands where large hardwoods were not controlled.

While the total number of hardwood stems 1 inch d.b.h. and larger increased with precommercial thinning, the number over 5 inches d.b.h. was almost eliminated. This result is further reflected in the basal area in pine (Table 3).

The hardwood component at age 10 had a tremendous impact on pine yields at age 20. With 4 square feet of hardwood basal area at age 10, the yield of loblolly at age 20 was 3,000 cubic feet. With 15 square feet of hardwood basal area at 10 years, loblolly volume dropped to 1,500 cubic feet at age 20, and 40 square feet of hardwood basal area further reduced the loblolly volume to 900 cubic feet (Figure 1).

STUDY 2: PINE DENSITY AND UNDERSTORY CONTROL

Treatments

A second study further refined the treatments to include control of density and of all understory hardwoods. Twenty-four plots were established at age seven to eight in four of the precommercially thinned compartments. At that time, the number of pine stems were reduced to 288, 432, and approximately 540 per acre. At age 14, the pine basal area was reduced to 60, 80, and 100 square feet through commercial harvest. All small hardwoods were removed on one half of the plots.

Growth Responses

Basal area growth increased at all three densities when all of the understory hardwoods were removed. Merchantable volumes also increased at age 20 for each density with removal of all understory hardwoods. Cubic volume was greatest in the stand having a 100-square-foot density with all of the understory hardwoods removed (Table 4).

As might be expected, board foot volumes at age 20 were greatest at the 60-square-foot level

Table 2. Number and size of stems by treatment: Age 20[1]

Stand treatment	Hardwoods 1" + d.b.h.	Hardwoods 5" + d.b.h.	Pine 1" = d.b.h.	Pine 5" + d.b.h.	Average d.b.h., all pine
	Stems per acre				Inches
(1) Hardwoods not controlled	2428	75	615	208	4.8
(2) Large hardwoods controlled	2411	21	672	413	5.7
(3) Pine precommercially thinned	3195	2	537	460	6.7

[1] *Source: Langdon and Trousdell.*

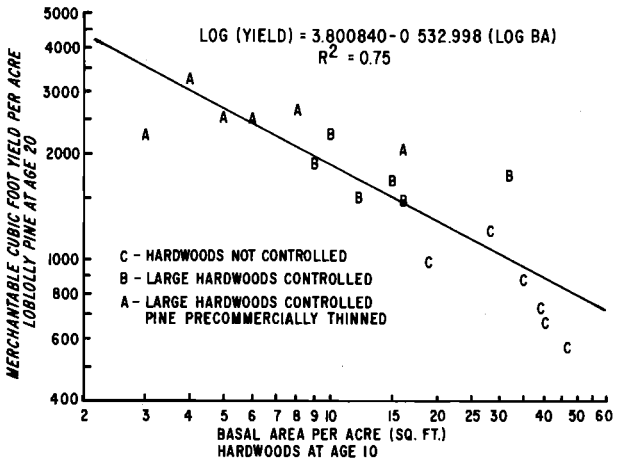


Figure 1. Relationship of hardwood basal area at age 10 and merchantable cubic foot yields at age 20. Source: Langdon and Trousdell 1974.

(Table 4). The average density when all hardwoods were removed was almost 5,400 board feet per acre and slightly less than 2,000 board feet per acre without complete hardwood removal.

FINANCIAL ANALYSIS

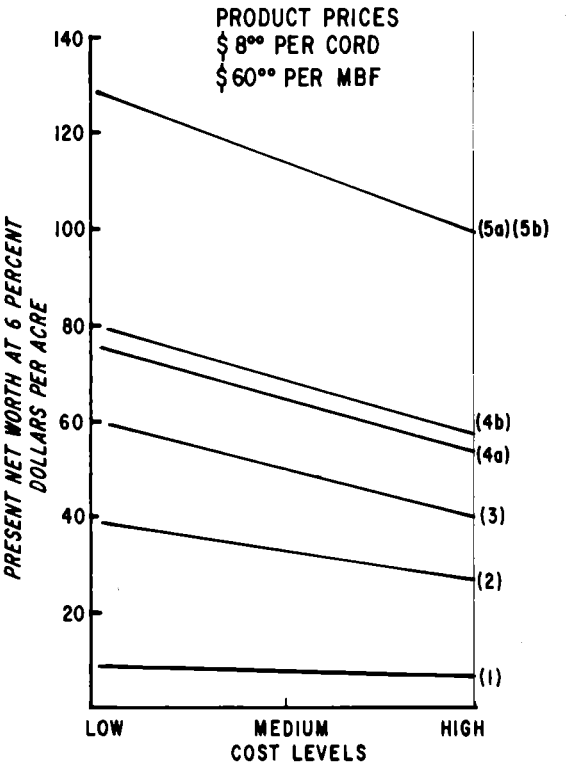
Study 1

Using the three levels of cultural treatment mentioned earlier and a range of low, medium, and high costs, the following picture emerges. *Each increased level of management provided*

Table 3. Basal area per acre by treatment: Age 20[1]

Stand treatment	Pine	Hard-wood	Total
	– – – Square feet – – –		
(1) Hardwoods not controlled	63	57	120
(2) Large hardwoods controlled	111	32	143
(3) Pine precommercially thinned	131	26	157

[1] *Source: Langdon and Trousdell.*



(1) -Control burn only
(2) -Control burn plus large hardwood control
(3) -Control burn plus large hardwood control plus precommercial thin
(4a)-(3) plus density control-60 sq. ft.
(4b)-(3) plus density control-100 sq. ft.
(5a)-(3) plus density control-60 sq. ft. plus understory hardwood control
(5b)-(3) plus density control-100 sq. ft. plus understory hardwood control

Figure 2. Present net worth at 6 percent and one combination of product prices for all treatments.

Table 4. Merchantable yields in cubic and board feet of pine at age 20 with density and hardwood controls[1]

Pine basal area level	Understory hardwoods not controlled		Understory hardwoods controlled		Yield increase[2]		Percent increase[2]	
Sq. feet	*Cu. ft.*	*Bd. ft.*	*Cu. ft.*	*Bd. ft.*	*Cu. ft.*	*Bd. ft.*		
60	1,978	2,989	2,390	6,078	412	3,089	21	103
80	2,351	1,311	2,816	5,720	465	4,409	20	336
100	2,590	1,596	3,037	4,374	447	2,778	17	174
Mean	2,306	1,965	2,748	5,391	442	3,426	19	174

[1] *Source: Langdon and Trousdell.*
[2] *Increase attributable to hardwood control.*

Figure 3. This area received no treatment except a controlled burn. It is heavily stocked with hardwoods five years after harvest.

Figure 4. This is the same area as in Figure 3, 17 years after harvest. The pine is now badly suppressed by the hardwoods.

Figure 5. Treatment on this plot consisted of a controlled burn and large hardwood removal following harvest of the previous pine stand. Six years after the harvest and treatment, the plot is well stocked with small pine and hardwoods.

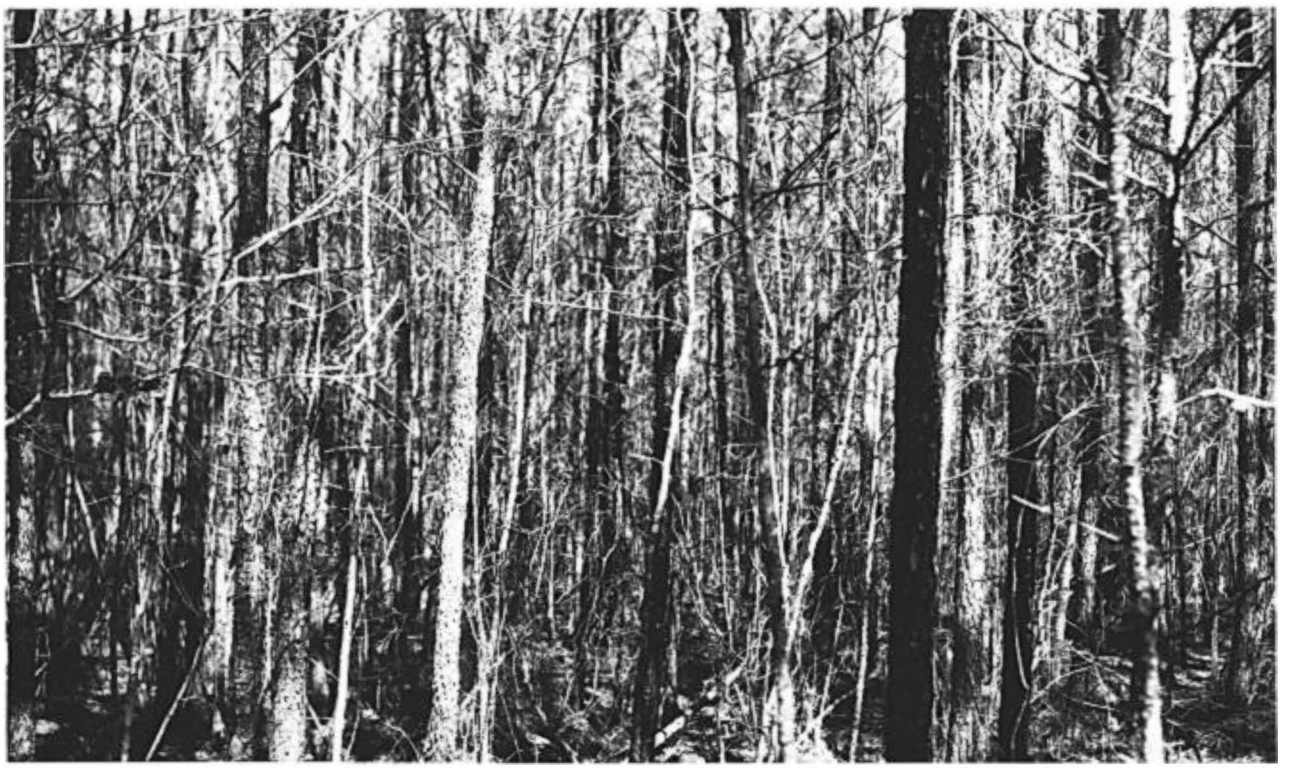


Figure 6. This is the same area as in Figure 5, 21 years after harvest.

a higher rate-of-return as well as a greater present net worth. The costs and product prices in Table 5 were used in the analysis. An annual cost of $1.50 per acre and a 2-percent simple interest increase in annual costs and product prices were used in this analysis. For example, an initial stumpage price of $6/cord would increase to $8.40/cord at age 20.

For comparative purposes, the *total* cost at each cost level should be considered instead of each individual cost item within a cost level (Tables 5 and 6). Note that in Table 6 returns are expressed in both rates of return in percent and present net worth at 6 percent in dollars.

Study 2

Further increases occurred in both rates of return and present net worth by using the same basic costs plus the cost of understory hardwood control and the addition of sawtimber product prices, as shown in Table 5.

Density control strongly influenced the amount of material in sawtimber size at age 20, but removal of all understory hardwoods had even more impact on the yield and economic returns (Table 7) when compared with no understory control. This result reinforces the findings in the first study.

Figure 2 illustrates the increase in returns as a result of the cumulative effect of each higher level

Table 5. Costs per acre and product prices per unit.

Year	Treatment	Cost level Low	Medium	High
0	Control burn	$ 4.00	$ 5.00	$ 6.00
0	Large hardwood control	6.00	11.00	16.00
6	Precommercial thin pine and small hardwoods controlled	12.00	18.00	24.00
	Subtotal costs, above treatments (not discounted)	$22.00	$34.00	$46.00
	Subtotal costs discounted at 6 percent[1]	18.46	28.69	38.92
10	All understory hardwoods controlled	$20.00	$27.00	$34.00
	Total costs, all treatments	$42.00	$61.00	$80.00
	Total costs discounted at 6 percent	29.62	43.76	57.89

Products	Price levels Low	Medium	High
Pulpwood per cord	$ 6	$ 8	$10
Sawtimber per mbf (Int. ¼)	40	60	80

[1] *Discounted costs are used only in present net worth computations.*

Figure 7. This 21-year-old stand received large hardwood control and a precommercial pine thinning six years after harvest.

Figure 8. This 20-year-old stand received the same treatment as the stand shown in Figure 7, plus understory hardwood control and basal area control maintained at 100 square feet.

Table 6. Rates of return and present net worth at 6 percent for three cost levels for each treatment

Pulpwood		Treatment and cost level: Preharvest control burn Low	Med.	High	Preharvest control burn & large hardwoods controlled[1] Low	Med.	High	Preharvest control burn, large hardwoods controlled, & precommercial thinning[2] Low	Med.	High
$/cord										
$ 6	RR in percent[3]	6.3	5.9	5.6	10.1	8.6	7.4	10.9	9.0	7.6
	PNW @ 6% in dollars[4]	.80	—	—	21.78	15.78	9.78	36.10	25.17	15.64
8	RR in percent	8.7	8.3	7.9	12.1	10.5	9.3	13.0	11.0	9.6
	PNW @ 6% in dollars	9.01	8.01	7.01	38.97	32.97	26.97	60.90	49.96	40.00
10	RR in percent	10.5	10.1	9.7	13.7	12.0	10.8	14.6	12.5	11.2
	PNW @ 6% in dollars	17.21	16.21	15.21	56.17	50.17	44.17	85.69	74.76	65.28

[1] *5 inches d.b.h. and larger.*
[2] *Plus control of hardwoods above 1 inch d.b.h.*
[3] *RR—Rate of return.*
[4] *PNW at 6 percent—present net worth at 6 percent.*

of management intensity for one price combination and at one interest rate. Present net worth for higher or lower costs than those illustrated can be determined by extending the lines on Figure 2. (This comparison would apply to $8 pulpwood and $60 sawtimber only.)

CONCLUSIONS

Successful management of stands under natural regeneration requires cultural treatments just as artificial regeneration does. In all treatments in the two studies, the more intensive the level(s) of treatment, the greater the yields and the net financial returns. In managing stands under natural regeneration for loblolly pine, the first step is to control large hardwoods—5 inches d.b.h. and above—at the time of regeneration. This treatment alone doubled production and could increase returns as much as three to four times. Precommercial thinning and control of small hardwoods —1 inch d.b.h. and above by age 6—is the next critical cultural practice. Combined with the large hardwood control at time of regeneration, this treatment tripled production and could increase returns by four to six times that of no treatment.

Density control strongly influences the early production of saw timber-size material. This treatment could be important in tailoring product mixes to fit local market conditions and other landowner objectives.

The most dramatic increase, if the previous steps are taken, can result from control of all hardwoods (including those under 1 inch d.b.h.) at an early age. Total hardwood control may more than double the returns from the previous steps.

Volume growth and financial returns will increase with each additional level of cultural treatment so long as costs are reasonable and adequate markets are available.

Table 7. Present new worth at 6 percent for density and understory hardwood controls

Prices: Pulpwood	Prices: Sawtimber	Uncontrolled: BA 60 ft²	Uncontrolled: BA 100 ft²	Controlled: BA 60 ft²	Controlled: BA 100 ft²
$/Cord	*$/Mbf*	*Dollars*			
6	40	28	34	56	60
6	60	55	48	109	98
6	80	81	62	162	136
8	40	39	55	61	76
8	60	65	69	114	114
8	80	91	83	167	153
10	40	49	75	66	92
10	60	75	89	119	131
10	80	101	103	173	169

Literature Cited

LANGDON, O. GORDON and KENNETH B. TROUSDELL. 1974. Increasing growth and yield of natural loblolly pine by young stand management. Symposium on Management of Young Pine. 288–299.

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