

**Evaluating Pine Regeneration Economic Opportunities:
Natural Regeneration, Cut-over Planted, and Oldfield Afforestation Pine Stands**

Coleman W. Dangerfield Jr.
Associate Professor, Extension Agricultural and Applied Economics
The University of Georgia
College of Agricultural and Environmental Sciences
Athens, GA 30602

and
David J. Moorhead
Associate Professor, Extension Forest Resources
Warnell School of Forest Resources
The University of Georgia
P.O. Box 1209
Tifton, GA 31793

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Introduction

The U.S. South, including Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, Puerto Rico, South Carolina, Tennessee, Texas, and Virginia, holds about two-fifths of the timberland in the U.S., with 23 percent of the nation's softwood growing stock and 44 percent of the hardwood growing stock (Haynes et al. 1995). Over 660,000 employees are working in forest products manufacturing firms in the South, with a combined annual payroll in excess of \$14.5 billion. Total economic impact of forestry and forest product industries on the Southern economy was in excess of \$90 billion in 1994.

Over the period 1990 to 2040, softwood harvests from U.S. forests are projected to rise 35 percent. Most of this increase will come from Southern forests. Southern softwood removals comprise 53 percent of the U.S. total timber removal value. Hardwood removals are 60 percent of U.S. totals. Southern hardwood annual growth exceeds harvest by 51 percent. Whereas, total softwood growth averages only 88 percent of harvest.

The growth of southern timber inventories has leveled off due to increased removals, lack of adequate regeneration, as well as environmental, and urban constraints that limit access to timber growing stocks. Enhancing the growth of existing timber stands, insuring adequate regeneration following harvest, plus afforestation of marginal rowcrop land, are important forest management activities that southern timber producers can implement to increase total timber supply and profits.

In 1988, there were 182 million acres of commercial forest in the South. There were 20.9 million acres of pine plantations, 40.9 million acres of naturally regenerated pines, and 26.9 million acres of mixed pine-hardwood stands from 25 to 50 percent pine. Projections indicate an increase in acres of planted pines with a corresponding decrease in the forest acres naturally

regenerated after tree harvest. In addition, over 8 million acres of former row crop land in the South has been afforested under the Agricultural Conservation Program (1936-92, 2.4 million acres), Soil Conservation Reserve Program (Soil Bank) (1956-60, 2.2 million acres), the Forestry Incentives Program (FIP) (1974-92, 2.1 million acres), and the Conservation Reserve Program (CRP) (1985-92, 2.0 million acres) (Kurtz et al. 1994). Total tree planting in the South in 1996 was over 1.8 million acres (Moulton and Snellgrove 1997).

At present, hardwood stands are most commonly regenerated naturally after harvest. On the other hand, pine stands are increasingly regenerated by planting after harvest. Common pine regeneration methods include natural regeneration or planting on cut-over sites following timber harvests and, afforestation of former agricultural cropland.

Purpose

To provide landowners with information about regeneration options we examined the management and economic opportunities of three pine regeneration methods: natural regeneration, plant cut over sites, and afforestation of rowcrop land.

Assumptions

The natural regeneration scenario was computer-modeled using WINYIELD 1.11 (Hepp 1996), while the cut over and oldfield scenarios were modeled using GaPPS Version 4.0 (Zhou and Bailey 1996). Each scenario was examined using common assumptions, where possible, to compare the scenarios. Site productivity, indicated site index (SI), averaged 68 feet at 25 years. This SI can be described as highly productive and would be expected where additional inputs such as site preparation, weed competition control, and fertilizer are added.

Financial parameters were set as: a 28 percent marginal federal tax bracket; 4.0 percent, uninflated, before tax discount rate to provide a conservative alternative investment return; South-wide 1996 prices of \$35 per cord for pulpwood, \$62 per cord for chip and saw (CNS), and \$243 per thousand board feet Scribner for sawtimber. Stumpage prices were projected uninflated. Total harvest expenses were computed at 12.5 percent of the harvest value, including 10 percent for marketing and 2.5 percent for ad valorem property taxes on timber harvested. Planting costs were charged at \$50 per acre. Management was charged at \$1 per acre per year. All results are reported uninflated, before taxes. Other variables such as hunting leases, and pine straw harvests were omitted from the assumptions because they would be common to each scenario and would add no real new information to this comparative study.

Three measures of financial performance are presented: *Soil Expectation Value* (SEV), *Internal Rate of Return* (IRR), and *Annual Equivalent Value* (AEV). Soil expectation value is calculated as the net present worth (revenues discounted to present year less costs discounted to present year at the discount rate) of perpetual repetitions of the investment. SEV is useful for comparing investments of unequal time length and for determining bare land value. Internal rate of return is the interest rate at which discounted revenues equal discounted costs. It assumes that all intermediate revenues are reinvested into the project. A project is considered profitable if the internal rate of return exceeds the discount rate. Annual equivalent value is the net present worth

expressed as an annuity over the planning horizon, computed at the discount rate. Annual equivalent value is a useful measure for comparing investments over unequal time periods.

Natural Regeneration

Natural regeneration of loblolly pine is a common practice, both planned and unplanned, across the South. Landowners may harvest pine from their lands with the goal of allowing natural regeneration to establish the new stand. Typically a seed tree or shelterwood method is employed leaving mature seed producing pines on each acre after harvest to provide seed for the new crop. Other options include seed, or seedlings-in-place, or seeding from adjacent stands as a natural regeneration source.

While natural regeneration methods can provide low cost and effective means to establish new stands, overstocking is common when favorable weather and seedbed conditions occur. Mechanical strip thinning is a recommended practice usually by age 3 to 5 years. Costs associated with precommercial thinning increase as stands age but can still provide good economic returns as is shown in this case where \$140 is spent in year 13.

This scenario utilizes findings from an earlier study by Moorhead, Dangerfield, and Edwards (1997). The naturally regenerated stands were established using seed tree method. Following harvest, all hardwood stems one inch in DBH and larger were treated by herbicide. At age 13 years, the stand was precommercially thinned (PCT) by hand crews using chainsaws to an approximate 12 x 12 foot spacing leaving 302 trees per acre that averaged 3.85 inches DBH and 23.24 feet in height.

Per acre management costs included \$5 for site preparation burning, \$40 for herbicide treatment, and \$140 for the PCT. Beginning in 1997, per acre charges for prescribed burns/fire breaks at three year intervals were assessed at \$8 for the initial burn, \$6 for the second burn, and \$5 for the subsequent burns.

The natural regeneration scenario was examined on a 35 year rotation with a thinning at age 28. The thinning treatment was a low thinning to a residual basal area (BA) of 65 square feet per acre. Timing of the thinning was set to maintain medium to low stand risk to southern pine beetle infestations, improve residual tree growth, and move cash-flows forward to improve financial performance. Volume removed had to meet a minimum 5 cords per acre to be considered commercially feasible.

At the thinning at age 28, the trees averaged 67 feet in height with a BA of 98. An average of 83 pulpwood stems per acre were harvested yielding 10.34 total cords per acre, Table 1. At final harvest at age 35, trees averaged 77 feet tall. The stand had a BA of 91 in 107 stems. A total of 32.90 cords were projected per acre. The product mix shifted to CNS and sawtimber with 25.13 cords and 7.77 cords, respectively. The 35 year rotation produced a total of 43.24 cords per acre in the two harvests. The uninflated IRR equaled 9.7 percent with an AEV of \$24.83 per acre, and a SEV of \$621 per acre, Table 2.

Planting Cut-over Stands

A study by Glover and Zutter (1993), examining alternative site preparation methods, found that small increases in the density of hardwood early in the life of the stand had a considerable negative effect on pine survival and basal area. The amount of hardwood also had a negative effect on mean pine diameter and total height, but these effects decreased at later ages with increasing pine mortality and intra-species competitive pressure when the pines were left unthinned.

This analysis is modeled on data from a study in the Georgia Piedmont (Dangerfield and Edwards 1995). The original stand of loblolly pine was harvested and replanted with improved loblolly pine seedlings on a spacing of 6 x 10 feet (726 trees per acre). The site preparation treatment was shear, root rake, burn, disk, fertilize, and herbicide at a cost of \$210 per acre. A thirty-three year rotation was chosen with thinnings at ages 18 and 25 years.

At the first thinning at age 18, average dominant height is projected at 50 feet with a BA of 137 square feet. An average of 215 stems per acre were harvested yielding 12.37 total cords per acre, Table 1. At the second thinning at age 25 years, average dominant height is projected at 64 feet with a BA of 136 square feet. An average of 127 stems per acre were harvested yielding 15.29 total cords per acre, Table 1. At final harvest at age 33, average dominant height is 75 feet, with a BA of 148 square feet in 145 stems. At 33 years, a total of 49.93 cords per acre were projected for harvest. Overall, this 33-year rotation produced a total of 77.88 cords per acre in the three harvests. The uninflated, IRR equaled 10.61 percent with an AEV of \$84.19 per acre, and SEV of \$2,104 per acre, Table 2.

Oldfield Afforestation

The most recent example of successful afforestation of rowcrop land is the Conservation Reserve Program (CRP), 1985-1992. Nationwide, tree planting accounts for only seven percent of all CRP practices. However, throughout the South, tree planting, primarily establishment of pine plantations, was the predominate CRP practice, with over 75 percent of CRP acres in the U.S. South planted to pine trees, mostly loblolly.

The impact of afforestation reflects the reallocation of capital used to produce annual crops, receipt of cost-share and annual CRP payments, the future market value of fiber and timber production along with potential shifts in the agricultural support infrastructure within communities.

A study done by Pienaar and Rheney (1996) at the University of Georgia examined the growth of oldfield pine plantations enrolled in the CRP. They examined wood-flows under growing conditions expected to be found in oldfield pine plantations, i.e., some weed competition, stand mortality, as well as the maximum wood-flow attainable under stand conditions where all competing vegetation is eliminated. In all cases, they found growth rates were substantially greater than those used to develop previous oldfield models.

Their study projects that new plantations can provide the same level of total production on only 59 percent of the acres of the former land base in previous plantations. The basis for the increased production is that residual nutrients applied to past crops and the lack of hardwood competition has increased site productivity above published soil survey values.

From an earlier study (Dangerfield and Moorhead 1997) our scenario model projects at the first thinning at age 18, the 494 oldfield site trees average dominant and co-dominant height was 62 feet with a BA of 157 square feet per acre. An average of 244 stems per acre were harvested yielding 21.16 total cords per acre, Table 1. At the second thinning at age 25 years, the 231 oldfield site trees average dominant height was 78 feet with a BA of 134 square feet. An average of 101 stems per acre were harvested yielding 18.54 total cords per acre, Table 1. At final harvest at age 33, trees average dominant height was 89 feet tall. The 33-year old stand had a BA of 136 square feet in 125 stems. At 33 years a total of 59.02 cords were projected harvested per acre. The 33 year rotation produced a total of 98.72 cords per acre in the three harvests. The uninflated IRR equaled 15.45 percent with an AEV of \$133.15 per acre, and a SEV of \$3,328 per acre, Table 2.

Implications

All three pine regeneration scenarios examined earned attractive returns for landowners. This indicates that in a wide range of situations, from mature forest to former agricultural land, landowners can earn profits when they take an active role in promoting pine regeneration. If a forest landowner harvests trees but cannot afford several hundred dollars an acre to replant trees on cut-over sites, planned natural regeneration is a good option. Obviously, replanting a cut-over stand with a pine plantation will earn a higher rate of return, and more total dollars per acre, than natural regeneration, \$25 compared to \$84 per acre per year for the two methods. But, cut-over plantations require more investment capital to be tied up while the trees are growing than does a naturally regenerated stand.

The highest returns, and easiest tree planting can be realized through afforestation of marginal rowcrop land. Several million acres of marginal rowcrop land across the U.S. South will earn higher producer returns planted to pine trees instead of to annual rowcrops. An Annual Equivalent Return of \$133 per acre from trees competes favorably with most annual crops on marginal rowcrop land, Table 2. Also, with afforestation of rowcrop land, less investment capital is tied up in the growing trees compared to cut-over plantations leading to a substantially higher IRR. The attractive growth and financial performances of tree plantations established on oldfield sites deserves a closer look by those landowners and investors interested in the practice of more intensive forestry.

Which ever route is taken, landowners can earn attractive returns by keeping their trees actively growing either through selective thinning or clearcutting and prompt replanting. Trees are a natural, sustainable resource that slow soil erosion, clean water and air, and provide habitat for wildlife and plants. These benefits are realized while landowners earn attractive incomes and boost employment and the economy.

Table 1. Modeled per acre stand parameters and woodflow of naturally regenerated, cut over, and oldfield loblolly pine, U.S. South, planted 1997.

Rotation	Stand Condition			Residual Component			Harvested Component		
Length	Age	Height	PAI ^a	Basal Area	Stems	Total Cords	Basal Area	Stems	Total Cords
Natural 35 years	28	67	1.1	65	114	21.30	33	83	10.34
	35	77	1.7	Final Harvest			91	107	32.90
			1.2	Totals/acre			124	190	43.24
Cut over 33 years	18	50	1.7	80	301	17.40	57	215	12.37
	25	64	3.1	80	148	23.57	56	127	15.58
	33	75	3.3	Final Harvest			148	145	49.93
			2.4	Totals/acre			261	487	77.88
Oldfield 33 years	18	62	2.4	80	250	21.70	77	244	21.16
	25	78	3.7	80	127	28.85	54	101	18.54
	33	89	3.8	Final Harvest			136	125	59.02
			3.0	Totals/acre			267	470	98.72

^aPAI = Periodic annual increment in cords per acre

Table 2. Projected uninflated financial performance of naturally regenerated, cut over, and oldfield loblolly pine, U.S. South, planted 1997.

Rotation	Internal Rate of Return (IRR%)	Annual Equivalent Value (AEV \$/ac)	Soil Expectation Value (SEV \$/ac)
Natural, 35-Year	9.7	25	621
Cut over, 33-Year	10.61	84	2,104
Oldfield, 33-Year	15.45	133	3,328

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