



Chemical versus Mechanical Site Preparation in Loblolly Pine Stand Management

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INTRODUCTION

Stand establishment is a very critical decision-making phase in the life of a pine plantation. Site preparation (chemical, mechanical, combinations with or without burning), species selection, seedling genetics, competition control (pre- and post-plant), fertilization, and spacing decisions made mostly prior to planting have long-term effects on stand survival, growth, wood yields, rotation age, and products grown. Site preparation goals include: control of competing vegetation, amelioration of soil conditions that restrict root growth, improving near-term nutrient status, minimizing near- and long-term negative site productivity impacts, and making the site easier to plant. Competition control through site preparation treatments and post-plant herbaceous weed control (HWC) are intended to enhance seedling survival and growth following planting. This paper will address modeled loblolly pine wood yields from clearcutting a 24-year-old stand without thinning (Pienaar and Rheney 1996), giving the product class distributions obtained by three stand establishment regimes, the cost of each regime, harvest revenues, rates of return, and net present value using three stumpage price sets.

GROWTH RESPONSE AND ECONOMICS OF CHEMICAL SITE PREP AND HERBACEOUS WEED CONTROL (HWC) VERSUS MECHANICAL SITE PREP AND NO HWC

Modeled wood flow estimates by Pienaar and Rheney (1996) found that loblolly pine growth and yield was much greater under a chemical site preparation, burn, HWC regime than with mechanical only; chop, burn or shear, pile, disk site preparation regime. They compared the three stand establishment regimes for clearcut product class distributions at age 24-years, including chip-n-saw (CNS; trees with a diameter at breast height (dbh) 4.5 ft above groundline of 9.6 inches or greater and no visible tree stem defect for 33-40+ ft, making some dimension lumber and the balance of each stem are chips) and pulpwood (PW; trees with a dbh of 4.6-9.5 inches and trees with a visible stem defect; fork, excessive branching and other defects were put in the pulpwood class). Historically, CNS has been 1.2- to 2-fold greater in value per ton than PW across the southeastern US.

Comparing the three stand establishment regimes, the chop, burn site preparation treatment had 62 tons of PW, 35 tons of CNS per acre at age 24-years and a mean annual increment growth rate of 4.0 tons per acre per year. The shear, pile, disk site preparation treatment had 56 tons of PW and 46 tons of CNS at age 24-years, with a mean annual increment growth rate of 4.3 tons per acre per year. The herbicide, burn, herbaceous weed control grew 70 tons PW and 78 tons CNS per acre by age 24-years, with a mean annual increment of 6.2 tons per acre per year. Herbaceous weed control (HWC) involves selective herbicides applied over the top of pine seedlings in the early spring of the first year to minimize herbaceous weed competition to improve available water, nutrients and sunlight, thus fostering pine survival and growth. The total cost per acre for each management regime (Table 1) was \$309 (chop, burn, seedlings, planting), \$364 (shear, pile, disk, seedlings, planting), and \$314 (chemical, burn, seedlings, planting, HWC (Maggard 2021)).

Timber revenues were analyzed using three stumpage price sets from TimberMart-South (TMS) first quarter 2023 Georgia pine stumpage prices: (a) the state-wide average; \$12/ton for PW and \$20/ton for CNS, (b) region 2 (Coastal Plain; the lower portion of the state); \$16/ton for PW and \$24/ton for CNS, and (c) region 1 (Piedmont to mountains; upper portion of the state); \$8/ton for PW and \$16/ton for CNS (Figure 1).

Using the Georgia state-wide average PW and CNS prices the chop, burn, plant regime produced \$1,444/acre of timber income. The shear, pile, disk regime produced a \$1,592/acre income at age 24-years with the clearcut. The chemical, burn, plant, HWC regime gave \$2,400/acre of income at age 24-years (Table 3). The rate of return (ROR) for the herbicide, burn, plant, HWC stand establishment regime was 8.84%, whereas the ROR for the chop, burn, plant was 6.64%, and the shear, pile, disk, plant was 6.34% (Table 4). The net present value (NPV; using a 5% discount rate) for the herbicide, burn, plant, HWC regime was \$430/acre, \$139/acre for the chop, burn regime and \$130/acre for the shear, pile, disk regime (Table 5).

Using the Georgia region 1 (Upstate) average PW and CNS prices the chop, burn, plant regime produced \$1,056/acre of timber income. The shear, pile, disk regime produced a \$1,184/acre income at age 24-years. The chemical, burn, plant, HWC regime gave a \$1,808/acre value (Table 3). The rate of return (ROR) for the chemical, burn, plant, HWC stand establishment regime was 7.57%, whereas the ROR for the chop, burn, plant was 5.25%, and the shear, pile, disk, plant was 5.04% (Table 4). The NPV for the herbicide, burn, plant, HWC regime was \$247/acre, while the NPV for the chop, burn, plant regime was \$18/acre and \$3/acre for the shear, pile, disk, plant regime (Table 5).

Using the Georgia region 2 (Coastal Plain) average PW and CNS prices the chop, burn, plant regime produced \$1,832/acre of timber income at 24-years. The shear, pile, disk regime produced a \$2,000/acre income. The chemical, burn, plant, HWC regime gave a \$2,992/acre value (Table 3). The rate of return (ROR) for the chemical, burn, plant, HWC stand establishment regime was 9.85%, whereas the ROR for the chop, burn, plant was 7.70%, and the shear, pile, disk, plant was 7.36% (Table 4). The NPV for the herbicide, burn, plant, HWC regime was \$614/acre, while the NPV for the chop, burn, plant was \$259/acre and the shear, pile, disk, plant regime was \$256/acre (Table 5).

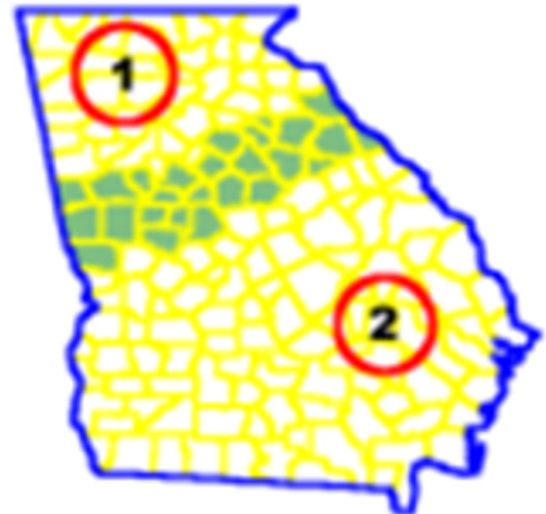


Figure 1: Georgia regions used for TimberMart-South stumpage and delivered prices. Region 1 is the Piedmont and Mountains and region 2 is the Coastal Plain and Sand Hills. Source: TMS, 2023.

Table 1. Cost assumptions (Maggard 2021) for a 24-year loblolly pine rotation under three levels of stand establishment treatments. Seedling cost using high quality open pollinated, bareroot loblolly pine @ \$90/1000 and planting 600 seedlings/ac.

Site prep treatment	Site prep \$/ac cost	Burn \$/ac cost	Seedling \$/ac cost	Planting \$/ac cost	1 st year Herb weed control \$/ac	Total \$/ac cost
Chop, burn	135	35	54	85	0	309
Shear, pile, disk	225	0	54	85	0	364
Herb, burn, HWC*	85	35	54	85	55	314

*Herbaceous weed control (HWC) applied overtop of seedlings during the first year.

Table 2. Modeled wood flow estimates for 24-year-old loblolly pine under three management levels (Pienaar and Rheney 1996).

Site prep treatment	Pulpwood tons/acre	Chip-n-saw tons/acre	Total tons/acre	Mean annual increment tons/ac/yr)
Chop, burn	62	35	97	4.0
Shear, pile, disk	56	46	102	4.3
Herbicide, burn, HWC*	70	78	148	6.2

*Herbaceous weed control (HWC) applied overtop of seedlings during the first year.

Table 3. Clearcut at age 24-years timber revenues by stand establishment regime using the three different TM-S Georgia first quarter 2023 (TMS 2023) pine stumpage price sets.

GA pine stumpage price set	Site prep treatment	Pulpwood \$/acre	Chip-n-saw \$/acre	Total \$/acre
State-wide	Chop, burn	744	700	1,444
	Shear, pile, disk	672	920	1592
	Herbicide, burn, HWC*	840	1560	2,400
Region 1	Chop, burn	496	560	1,056
	Shear, pile, disk	448	736	1184
	Herbicide, burn, HWC	560	1,248	1,808
Region 2	Chop, burn	992	840	1,832
	Shear, pile, disk	896	1104	2,000
	Herbicide, burn, HWC	1,120	1,872	2,992

*Herbaceous weed control (HWC) applied overtop of seedlings during the first year.

Table 4. Rate of return for the three TM-S Georgia first quarter 2023 (TMS 2023) pine stumpage price sets and the three stand establishment regimes.

Pine stumpage price set	Site preparation treatment	Rate of Return (%)
State-wide	Chop, burn	6.64
	Shear, pile, disk	6.34
	Herbicide, burn, HWC*	8.84
Region 1	Chop, burn	5.25
	Shear, pile, disk	5.04
	Herbicide, burn, HWC	7.57
Region 2	Chop, burn	7.70
	Shear, pile, disk	7.36
	Herbicide, burn, HWC	9.85

*Herbaceous weed control applied overtop of seedlings during the first year.

Table 5. Net Present Value (NPV) using a 5% discount rate for the three TM-S Georgia first quarter 2023 stumpage price sets (TMS 2003) and stand establishment regime.

Pine stumpage price set	Site preparation treatment	Net Present Value (\$/ac)
State-wide	Chop, burn	139
	Shear, pile, disk	130
	Herbicide, burn, HWC*	430
Region 1	Chop, burn	18
	Shear, pile, disk	3
	Herbicide, burn, HWC	247
Region 2	Chop, burn	259
	Shear, pile, disk	256
	Herbicide, burn, HWC	614

*Herbaceous weed control applied overtop of seedlings during the first year.

SUMMARY AND CONCLUSIONS

The pre-plant herbicide treatment followed a burn then by first year post plant herbaceous weed control produced 45% and 56% more wood (148 tons) when compared to the two mechanical only treatments (97 tons for chop, burn and 102 tons for the shear, pile, disk). The herbicide, burn, HWC establishment regime also grew 43 more tons/acre (78 versus 35 tons CNS) of higher valued chip-n-saw wood than the chop, burn and 32 tons/acre more (78 versus 46 tons CNS) than the shear, pile, disk regimes. Establishment costs differences of \$309/acre for the chop, burn, plant; \$364/acre for the shear, pile, disk, plant; and \$314/acre for the herbicide, burn, plant, HWC were small, yet the ROR and NPV values for the herbicide, burn, plant, HWC regime values were greater than the chop, burn or shear, pile, disk regimes.

Pre-plant site preparation that includes an appropriate herbicide prescription applied at the right time can dramatically reduce woody competition that adversely affects planted pine growth (Glover and others 1986, Miller and others 1991, Haywood and Tiarks 1990, Glover and Zutter 1993). Herbicides provide the best long-term control of woody vegetation. Historically, mechanical treatments have not been proven to provide significant, long-term woody plant control, which is needed for maximizing long-term planted pine growth.

Herbaceous weed control in the first growing season after planting can be a cost-effective forest management tool, even in light of the last decade's relatively depressed stumpage prices (TMS 2014 - 2023). A single banded (4, 5 or 6 feet wide) application with the right forest herbicide applied at the appropriate timing and dosage can increase loblolly pine early growth. In droughty first growing seasons after plantation establishment and where competing herbaceous vegetation is abundant, HWC can significantly increase pine survival. The HWC benefits are greatest when both survival and early growth are improved. For those that are establishing low density stands (<500 to 550 TPA), maximizing early survival is critical. Work done by Lauer and others (1993) on loblolly pine noted that post-plant HWC improved loblolly pine growth by an average of 25% at age nine years. When using a growth projection model, HWC reduced rotation age by three years (from age 25-years without HWC back to age 22-years) when only growth gains were realized and by up to six years (from age 25-year without HWC to age 19-years) when survival and growth were both significantly improved. Economically, HWC is attractive for those that are planting a stand for pine straw production by possibly reducing the time

to the first rake or when one considers a reduction in rotation age. Site by site prescriptions should be made to maximize HWC benefits. Hardwoods, shrubs (i.e. gallberry, titi, and waxmyrtle), and volunteer pines can have a longer lasting negative effect on stand growth and should be controlled before planting (Glover and Zutter 1993, Miller and others. 1991).

LITERATURE CITED

- Glover, G.R, Creighton, J.L., and D.H. Gjerstad. 1986. Vegetation control significantly increases loblolly pine growth for ten years. Auburn Univ. Silvi. Herb. Coop., Auburn Ala. Res. Note 86-6.
- Glover, G.R. and B.R Zutter. 1993. Loblolly pine and mixed hardwood stand dynamics for 27 years following chemical, mechanical and manual site preparation. Can. J. For. Res. 23:2126-2132.
- Haywood, J.D. and A.E. Tiarks. 1990. Eleventh-year results of fertilization, herbaceous, and woody control in a loblolly pine plantation. SJAF 14(4):173-177.
- Lauer, D.K., G.R. Glover, and D.H. Gjerstad. 1993. Comparison of duration and method of herbaceous weed control on loblolly pine response through mid-rotation. Can. J. For. Res. 23:2116-2125.
- Maggard, A. 2021. Costs & trends of southern forestry practices 2020. FOR-2115. The Alabama Cooperative Extension System. 6 p.
- Miller, J.H., B.R. Zutter, S.M. Zedaker, M.B. Edwards, J.D. Haywood, and R.A. Newbold. 1991. A regional study on the influence of woody and herbaceous competition on early loblolly pine growth. SJAF 15(4):169-179
- Pienaar, L.V. and J.W. Rheney. 1996. Potential productivity of intensively managed pine plantations. GA Consortium for Tech. Competitiveness in Pulp and Paper. Final Report. 41 p.
- TimberMart-South. 2023. TimberMart-South Georgia 1st qtr. 2023 stumpage prices. The Frank W. Norris Foundation, Athens, GA.

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