Series paper #8

Economics of growing slash and loblolly pine under various levels of management – a 24- versus 33-year rotation comparison

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Abstract

Since early 1998 forest industry, forestland ownership, global markets, and wood supply and demand (pulpwood, sawtimber, chips, etc.) regionally and world-wide have changed dramatically. Non-industrial private forest (NIPF) landowners have realized reduced product market availability and increased price uncertainty during this period in the southeastern United States. Lower Atlantic and Gulf Coastal Plain NIPF landowners seek management options utilizing two commonly available pine species; loblolly (*Pinus taeda* L.) and slash (*Pinus elliottii*, Engelm.) to enhance feasibility, profitability, and cash-flow of production forestry enterprises. At the same time, NIPF landowners desire heightened flexibility across time required to achieve marketable forest products. This paper examines feasibility, profitability, and cash-flow of management options affecting wood-flow for slash and loblolly pine plantations under two rotation lengths, 24- and 33-years, including thinning, fertilization, and pine straw harvests under alternative levels of productivity and product prices. Financial measures of profitability calculated include soil expectation value (SEV), annual equivalent value (AEV), and rate of return (ROR).

Introduction

Private non-industrial forest (NIPF) landowners in the Atlantic and Gulf Coastal Plain from South Carolina to Mississippi question whether to plant loblolly or slash pine on cut-over and old-field sites. They also question spending moderate to relatively large sums of money in intensive forest management and different rotation ages under the current and anticipated stumpage prices and economic uncertainty. To address these questions, we used the Georgia Pine Plantation simulator (GaPPs 4.20) growth and yield Model developed by Bailey and Zhao (1998). The economics (SEV, AEV, and ROR) of 24-year rotation versus a 33-year rotation for slash and loblolly pine under different levels of forest management are the focus of this paper.

Methodology

Common assumptions

The rotation age was set at either 24- or 33-years for loblolly and slash pine plantations. A discount rate of 8 percent was used to calculate soil expectation value (SEV) and annual equivalent value (AEV). A composite rate of return (ROR) was also calculated after intermediate costs and returns were discounted at 8 percent. Fire protection cost was assumed$2/ac/yr, stand management at $2/ac/yr, and property

taxes at $5/ac/yr. Thus, the total annual costs for each year of the rotation was $9/acre. This value cost goes in the transaction table as an annual cost during the rotation. The present value of this net, annual cost flow is $94.75 during the 24-year rotation and $103.62 for the 33-year rotation. Results are reported in constant dollars, before taxes. Land was assumed to be owned throughout the scenarios.

Site Preparation and Planting Costs

► The relatively low site preparation and planting cost of $125/acre could include machine planting and the use of a post plant herbicide to control herbaceous weeds on an old-field site or glyphosate @ 1 gallon/ac or prescribe burning (low level) site preparation and roughland or hand planting on a cutover site.

► The more moderate ($250/acre) establishment cost could include a mechanical site prep treatment, burn and plant or a herbicide, burn, plant, and herbaceous weed control (Dubois and others. 1999).

► The higher ($375/acre) establishment cost could include a combination of chemical and mechanical site preparation as can be the case on many flatwoods cutover sites.

Site preparation options and associated costs vary extensively by location, prior stand history, harvesting utilization, landowner objectives, monies available, and anticipated future stumpage value and demand. The assumption used was that level of site preparation intensity was matched to level of competition control needed so that wood-flows were comparable within site productivity levels, after site preparation and planting.

Georgia stumpage Prices, reported through Timber Mart-South© (TM-S) for 1st quarter year 2004 average, used in this analysis for loblolly and slash were net of property taxes at harvest (2.5 percent) and net of marketing costs (8 percent). The low TM-S prices for pulpwood and chip&saw were used for thinning prices and average TM-S prices for pulpwood (PW), chip-n-saw (CNS), and sawtimber (ST) are used for the clearcut. Cash and net converted prices are found in Table 1. Product class specifications are: PW at a d.b.h. of 4.5 to 9 inches to a 3 inch top; CNS at a d.b.h of 9 through 12 inches to 6 inch top; and, ST with a d.b.h greater than 12 inches to a 10 inch top (Table 2).

Species specific assumptions

The slash pine scenarios assumed 500 living trees per acre (TPA) at age 5-years-old. Base mean annual increments of 1.91 cd/ac/yr (5.26 tons/ac/yr) @ age 33-years-old and 2.09 cd/ac/yr (5.77 tons/ac/yr) @ age 24-years-old without fertilization and thinning were assumed (Table 6 and 8). The base slash scenario woodflow was approximately 12 to 15 percent less than base loblolly woodflow (Shiver and others 1999) for the 24- and 33-year rotations. The assumed fertilizer applications increased slash pine merchantable volume by an average of 0.50 cd/ac/yr (1.38 tons/ac/yr) for eight to ten years following treatment (Jokela and Stearns-Smith 1996).

The loblolly pine survival was assumed to be 500 TPA at age 5-years-old. The base mean annual increments for loblolly were assumed to be 2.15 cds/ac/yr (5.95 tons/ac/yr) through age 33-years and 2.35 cd/ac/yr (5.83 tons/ac/yr) through age 24-years without fertilization or thinning (Table 7 and 9). The base loblolly woodflow was approximately 11 to 15 percent greater than the slash base woodflow (Shiver and others 2000) at age 24- and 33-years. The assumed fertilizer applications aggressively increased loblolly pine merchantable volume by an average of 0.65 cd/ac/yr (1.79 tons/ac/yr) for eight to ten years (NCSUFNC 1998).

Scenarios for the 24-year Rotation

The following are the nine slash (Table 6) and loblolly (Table 7) pine scenarios:
(1) no thinning, no pine straw income, and no fertilization,
(2) thin (at age 15-years to 65 ft^2/ac), no straw, no fertilization ,
(3) no thin, fertilize at age 16-years, no straw,
(4) no thin, fertilize @ 6-years and rake pine straw from age 8-years through age 23-years @ $50/ac/yr,
(5) no thin, fertilize at ages 6- and 16-years and rake pine straw from age 8-years through age 23-years @ $100/ac/yr,
(6) thin, fertilize after the thinning (age 16-years), no straw,
(7 and 8) thin, fertilize at age 6-years, and rake straw @ $50 or $100/ac/yr from age 8-through 14-years, and
(9) thin, fertilize at ages 6- and 16-years and rake pine straw at $100/ac in years 8 through 14 and $50/ac/yr in years 17 through 23-years.

Scenarios for the 33-year Rotation

The following are the seven slash (Table 8) and loblolly (Table 9) pine scenarios:
(1) thin @ age 15- and 24-years to 65 ft^2/ac, no straw, no fertilization ,
(2) thin @ age 15- and 24-years to 65 ft^2/ac, no straw, fertilize @ age 25-years,
(3) thin @ age 15- and 24-years to 65 ft^2/ac, no straw, fertilize @ ages 16- and 25-years,
(4) thin @ age 15- and 24-years to 65 ft^2/ac, pine straw @ $50/ac/yr from age 8-through age 14-years, no fertilization,
(5) thin @ age 15- and 24-years to 65 ft^2/ac, pine straw @ $100/ac/yr from age 8-through age 14-years, fertilize @ age 6-years,
(6) thin @ age 15- and 24-years to 65 ft^2/ac, pine straw @ $100/ac/yr from age 8-through age 14-years, fertilize @ age 6- and 25-years, and
(7) thin @ age 15- and 24-years to 65 ft^2/ac, pine straw @ $100/ac/yr from age 8-through age 14-years, clean-up in year 16, pine straw @ $50/ac/yr from age 17-through age 23-years, fertilize @ age 6-, 16-, and 25-years.

Forest management activities

Thinning

For the 24-year rotation, the thinning scenarios include no thinning (scenario 1, 3-5) or one thinning at 15-years-old (scenario # 2 and 6-9). Total woodflow of the scenario with thinning is approximately 95 percent of total woodflow of the scenario without thinning for slash and loblolly without fertilization. For the 33-year rotation, all scenarios

for both pine species include two thinnings; @ age 15- and 24-years-old. Residual basal area (RBA), after thinning (5th row with selection from below) is set at 65 sq. ft/ac for both rotation ages.

Fertilization

A fertilizer and application cost of $100/ac for slash and loblolly per application at age 6-years, 16-, and/or 25-years were assumed. Fertilization with 150 then 200 N + 40 elemental-P (as diammonium phosphate and urea) per acre was part of this scenario to maintain pine straw production rates (Dickens 1999), to enhance wood volume (NCSUFNC 1998), and change product class distribution (Peinaar and Rheney 1996, Dickens 2001). Fertilization timing at age 6-years-old was two years prior to the initiation of straw raking (just prior to canopy closure). The second application, ten years later, was just after a thinning (thinning scenario) and after the response (wood and straw) to the first application has become negligible. The third application at age 25-years in the 33-year rotation scenario was to increase more valuable chip-n-saw and saw timber volume. The periodic fertilizer application costs are converted to present values (PV) in year one, then re-computed as annual equivalent values (AEV). These AEVs were then put in the transaction table as annual expense cash-flows (Table 3).

Pine straw

The pine straw income assumptions included were as follows: $50 and $100/ac/yr raking income for the slash and loblolly scenarios has been noted in south (slash) and central (loblolly) Georgia between 1998 and 2003 (Doherty 2004). Pine straw is raked starting in year 8 (approximating canopy closure) for slash and loblolly pine. Periodic pine straw income was converted to present values (PV) in year one, then re-computed as annual equivalent values (AEV) at the discount rate of 8 percent. These AEVs were then put in the transaction table as annual income cash-flows (Table 4).

Typically pine straw raking in Georgia ceases after the first thinning due to large understory vegetation growth in thinned stands and the abundance of unthinned, relatively clean loblolly and slash pine stands available. Yet many acres of thinned loblolly and longleaf stands in South and North Carolina are raked. Some pine straw contractors in Georgia anticipate that some thinned loblolly, longleaf, and slash pine stands may be rakeable in the future (supply and demand). Therefore we included a scenario for loblolly and slash pine with raking two years after thinning at half the income rate prior to the thinning. There was an associated clean-up cost to get the stand rakeable of $70/acre (Table 5a). Scenarios that included pine straw income for both species are #'s 4, 5, and 7-9 (Table 6 and 7) for the 24-year rotation and #'s 4-7 for the 33-year rotation.

Wood Flow

The 1.91 and 2.15 (33-year rotation) and 2.09 and 2.35 cd/ac/yr (24-year rotation) productivity levels for slash and loblolly, respectively, are realistic on most cut-over sites with chemical site preparation and post-plant herbaceous weed control (Pienaar and

Rheney 1996) and is conservative on most old-field sites. The 0.5 (slash) and 0.65 (loblolly) cds/ac/yr increase in wood production is moderate (slash) to aggressive (loblolly) compared to other published reports (Jokela and Stearns-Smith 1993, Martin and others 1999, NCSFNC 1999) with nitrogen plus phosphorus fertilization at ages 6-, 16- and/or 25-years. No increase in pine straw income per acre was assumed with fertilization. Fertilization studies (Blevins and others 1996, Dickens 1999) illustrate that pine straw production can be increased by an average of 40 to 50 percent over unfertilized stands. Fertilization was included in the pine straw production scenarios to maintain straw production as nutrients are removed/displaced with each raking.

Results

When considering results, more weight should be given to the relative differences among scenarios than to the numeric values calculated for any one scenario. Among-scenario differences are more important than absolute values because scenarios were analyzed under a common set of conservative assumptions. Values realized for your individual case may be greater or less than those of this study. However, the relative magnitude of difference between and ranking of the scenarios should be similar under a different set of underlying assumptions.

Low and High SEV, AEV, and ROR scenarios

Using the aforementioned costs, stumpage prices, growth rates, and product class distribution assumptions, the 24-year no-thin base scenario gave to lowest SEV, AEV, and ROR values within a SP+PL level for both loblolly and slash pine (Tables 6 and 7) when compared to all other 24- and 33-year rotation scenarios. The highest SEV, AEV and ROR values within a SP+PL level were realized with the 24-year no-thin, fertilize, and rake pine straw @ $100/ac/yr from age 8- through age 23-years scenario (Tables 6 and 7) for loblolly and slash pine.

Soil expectation values (SEV) and annual equivalent values (AEV) where the 24-year rotations were higher than similar 33-year rotation scenarios

The SEVs for the one-thin, no fertilization 24-year scenario (#2) were $44/ac and $71/ac greater than base scenario for the 33-year rotation (#1; two-thinnings and no fertilization) for slash and loblolly pine, respectively at the $125/ac SP+PL cost level. As the SP+PL cost level increased, the SEV differences decreased to $30/ac and $59/ac (@ $250/ac), and $18/ac and $46/ac for slash and loblolly pine (@ $375/ac SP+PL), respectively (Tables 6 – 9). SEVs were consistently higher, by $87/ac (slash @ $375/ac SP+PL) to $149/ac (loblolly @ $125/ac SP+PL), when comparing the 24-year rotation scenario #9 to the 33-year rotation scenario #7 for both species. AEVs were slightly higher for the 24-year rotation scenario # 2 when compared to the 33-year rotation scenario # 1; by $2/ac/yr (slash @ $375/ac SP+PL) to $6/ac/yr (loblolly @ $125/ac SP+PL). AEVs were higher for the 24-year rotation scenario # 9 when compared to the 33-year rotation scenario # 7; by $7/ac/yr (slash @ $375/ac SP+PL) to $12/ac/yr (loblolly @ $125/ac SP+PL; Tables 6-9).

Rate of return (ROR) values where the 24-year rotation scenarios were higher than similar 33-year rotation scenarios

The ROR values for the one-thin, no fertilization 24-year scenario (#2) were 1.03 and 1.50 percentage points greater than base 33-year rotation scenario (#1; two-thinnings and no fertilization) for slash and loblolly pine, respectively at the $125/ac SP+PL cost level. As the SP+PL cost level increased, the ROR value differences decreased to 0.37 and 0.76 percentage points (@ $250/ac) for slash and loblolly pine respectively and 0.33 percentage points (@ $375/ac) for loblolly pine (Tables 6 – 9). RORs were consistently higher, by 1.06 (slash @ $375/ac SP+PL) to 3.25 percentage points (loblolly @ $125/ac SP+PL), when comparing the 24-year rotation scenario #9 to the 33-year rotation scenario #7 for both species (Tables 6-9).

Soil expectation value (SEV) and annual equivalent value (AEV) where the 33-year rotation was higher than the similar 24-year rotation scenario

The 33-year rotation scenario #5 (fertilize at age 6-years, rake @ $50/ac/yr from age 8 through 14-years, thin @ 15- and 24-years) produced higher SEVs than the similar 24-year rotation scenario (#7; fertilize at age 6-years, rake @ $50/ac/yr from age 8- through age 14-years, thin @ 15-years). The increased SEVs ranged from $26 to $51/ac for loblolly and $51 to $76/ac for slash pine. The 33-year rotation scenario #5 produced slightly higher AEVs than the similar 24-year rotation scenario by $2 to $ $6/ac/yr for loblolly and slash pine (Tables 6-9).

Rate of return (ROR) where the 33-year rotation was higher than the similar 24-year rotation scenario

The slash pine 24-year rotation scenario #2 (@ $375/ac SP+PL) ROR was slightly less than the corresponding 33-year rotation scenario (#1) ROR by 0.02 percentage points. The 33-year rotation scenario #5 (fertilize at age 6-years, rake @ $50/ac/yr from age 8 through 14-years, thin @ 15- and 24-years) produced higher RORs than the similar 24-year rotation scenario (#7; fertilize at age 6-years, rake @ $50/ac/yr from age 8- through age 14-years, thin @ 15-years). The increased RORs ranged from 0.72 to 1.49 percentage points for slash pine and 0.40 to 1.03 percentage points for loblolly pine (Tables 6-9).

Summary

Using the aforementioned assumptions, the 24-year rotation for slash and loblolly pine gave overall slightly greater SEVs, AEVs, and RORs than the 33-year rotation when comparing the lowest input (no fertilization, no pine straw) and highest (fertilization prior to canopy closure and after one year thinnings, and pine straw @ $100 then $50/ac/yr) management schemes with thinning. The 33-year rotation scenario with fertilization @ age 6-years, pine straw @ $50/ac/yr from age 8- through age 14-years, and two thinnings produced higher SEVs, AEVs, and RORs than the similar 24-year rotation scenario with fertilization @ age 6-years, pine straw @ $50/acyr from age 8- through age 14-years, and one thinning (Tables 6-9). SEV, AEV, and IRR differences decreased for both species as site prep and plant (SP+PL) costs increased.

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Table 1. Product prices, cash and net (net of property taxes and marketing costs) per cord stumpage prices used in the profitability analysis of slash and loblolly scenarios, Georgia State average, price per ton (1stQ TM-S 2004).

Item, Price level	Cash or net	Pulpwood ($/Ton)	Chip-N-Saw ($/Ton)	Sawtimber ($/Ton)
Low	cash	5.04	21.36	35.91
	net	4.51	19.12	32.14
Medium	cash	6.42	25.80	40.97
	net	5.75	23.09	36.51

Table 2. Product class specifications.

Product/Item	Pulpwood	Chip-N-Saw	Sawtimber
Small end diameter (inches)	3	6	10
Minimum length (feet)	5	8	8
Length Increment (feet)	1	4	8

Table 3. Fertilizer costs, $100/acre/periodic application, per acre cost levels expressed as present values and annual equivalent values (AEV), as used in the profitability analysis for 24- and 33-year slash and loblolly scenarios discounted at 8%.

Rotation (yrs)	Applied (yrs)	Present value of a periodic cost ($/ac)	Annual equivalent value of the periodic cost ($/ac/yr)
24	6	63.02	5.99
	16	29.19	2.77
	6, 16	92.21	8.76
33	6	63.02	5.47
	6, 16	92.21	8.01
	6, 25	77.62	6.74
	16, 25	43.79	3.80
	6, 16, 25	106.81	9.28
	25	14.60	1.27

Table 4. Pine straw periodic per acre income levels expressed as present values and annual equivalent values (AEV) as used in the profitability analysis of slash and loblolly pine scenarios over 24- and 33-year rotations discounted at 8%.

Rotation age	Thin scenario	Periodic income/ac/yr. raked ($/ac)	Present value of periodic income ($/ac)	AEV of periodic income ($/ac/yr)
24 yrs.	Thin at Age 15 years	50 & 0[1]	140.64	13.36
		100 & 0[1]	281.28	26.72
		100 & 50[2]	351.64	33.40
	No thin	50[3]	239.11	22.71
		100[3]	478.21	45.42
33 yrs	Thin at age 15 & 25 years	50 & 0[1]	140.64	12.21
		100 & 0[1]	281.28	24.43
		100 & 50[2]	351.64	30.54

[1] With thinning, pinestraw raked in years 8-14, for 24- and 33-year rotations.
[2] With thinning, pinestraw raked in years 8-14 and 17-23, for 24- and 33-year rotations.
[3] With no thinning, pinestraw raked in years 8-23, for 24-year rotation only.

Table 5a. Clean-up cost, in year 16, after thinning of slash and loblolly pine scenarios over 24- and 33-year rotations, expressed as present values and annual equivalent values (AEV) as used in the profitability analysis discounted at 8%.

Rotation	Clean-up cost in year 16 ($/ac)	Present value of clean-up cost ($/ac)	AEV of clean-up cost ($/ac/yr)
24 years	70	20.43	1.94
33 years			1.77

Table 5b. Stand management cost including active stand management, fire protection, and prescribed fire for loblolly and slash plantations with 24- and 33-year rotations (PV calculated at 8%).

Rotation	Management cost ($/ac/yr)	Present value of Management cost year 1, ($/ac)
24 years	9	96.07
33 years		103.62

Table 6. A comparison of **slash pine plantation** management scenarios[1] under a 24-year rotation and their effect on economic variables, with site prep and plant (SP&PL) cost of **$125, $250, and $375/acre**.

Treatment					SP&PL @ $125			SP&PL @ $250			SP&PL @ $375		
Scenario # Fert. @ Yr.	Thin yr 15	Pine straw ($/ac)	% PW	MIA[2] Tons/Cords	SEV[3] ($/ac)	AEV[4] ($/ac)	ROR[5] (%)	SEV[3] ($/ac)	AEV[4] ($/ac)	ROR[5] (%)	SEV[3] ($/ac)	AEV[4] ($/ac)	ROR[5] (%)
1 N	N	N	60	5.60, 2.09	72	6	9.30	-76	-6	6.96	-225	-18	5.48
2 N	Y		46	5.40, 2.01	171	14	10.89	22	2	8.28	-126	-10	6.67
3 Y, 16	N	N	48	6.12, 2.28	145	12	10.19	-3	0	7.96	-152	-12	6.53
4 Y, 6		50[6]	52		369	29	15.16	220	18	10.95	72	6	8.77
5 Y, 6, 16		100[6]	43	6.66, 2.48	689	55	24.64	541	43	15.71	392	31	12.27
6 Y, 16	Y	N	40	5.98, 2.23	237	19	11.51	88	7	9.00	-60	-5	7.43
7 Y, 6		50 & 0[7]	43		350	28	13.83	201	16	10.46	53	4	8.53
8 Y, 6		100 & 0[7]			517	41	18.12	368	29	12.87	220	18	10.31
9 Y, 6, 16		100 & 50[8]	38	6.39, 2.38	609	49	19.42	461	37	13.80	312	25	11.12

Table 7. A comparison of **loblolly pine plantation** management scenarios[1] under a 24-year rotation and their effect on economic variables, with site prep and plant (SP&PL) cost of **$125, $250, and $375/acre**.

Treatments					SP&PL @ $125			SP&PL @ $250			SP&PL @ $375		
Scenario # Fert. @ Yr.	Thin yr 15	Pine straw ($/ac)	% PW	MIA[2] Tons/Cords	SEV[3] ($/ac)	AEV[4] ($/ac)	ROR[5] (%)	SEV[3] ($/ac)	AEV[4] ($/ac)	ROR[5] (%)	SEV[3] ($/ac)	AEV[4] ($/ac)	ROR[5] (%)
1 N	N	N	60	5.83, 2.35	121	10	10.04	-27	-2	7.66	-175	-14	6.16
2 N	Y		46	5.61, 2.26	247	20	11.91	99	8	9.18	-50	-4	7.51
3 Y, 16	N	N	48	6.43, 2.59	194	16	10.76	45	4	8.50	-103	-8	7.05
4 Y, 6		50[6]	52		418	33	15.62	270	22	11.42	122	10	9.24
5 Y, 6, 16		100[6]	43	7.15, 2.88	782	63	24.98	633	51	16.24	485	39	12.85
6 Y, 16	Y	N	40	6.28, 2.53	316	25	12.44	167	13	9.81	19	2	8.17
7 Y, 6		50 & 0[7]	43		421	34	14.63	273	22	11.16	125	10	9.18
8 Y, 6		100 & 0[7]			588	47	18.83	440	35	13.51	292	23	10.91
9 Y, 6, 16		100 & 50[8]	38	6.90, 2.78	738	59	20.56	589	47	14.83	441	35	12.08

[1] Uninflated, 8% discount rate, before taxes, GaPPS v 4.20

[2] MAI = Mean Annual Increment of wood growth, Tons & Cords/A/yr.

[3] SEV = Soil Expectation Value, calculated from perpetual rotations.

[4] AEV = Net Annual Equivalent Value, net present worth as annuity.

[5] ROR = Rate of Return (percent).

[6] With no thinning, pinestraw raked years 8-23.

[7] With thinning, pinestraw raked years 8-14.

[8] With thinning, pinestraw raked years 8-14 and 17-23.

Table 8. A comparison of **slash pine plantation** management scenarios[1] under a **33-year rotation** with thinning in years 15 and 24 and their effect on economic variables, with site prep and plant (SP&PL) cost of **$125, $250, and $375/acre**.

Treatments						SP&PL @ $125			SP&PL @ $250			SP&PL @ $375		
Scenario # Fert. @ yr.	Pine straw ($/ac)	% PW	% CNS	% St	MAI[2] Ton, Cord	SEV[3] ($/ac)	AEV[4] ($/ac)	ROR[5] (%)	SEV[3] ($/ac)	AEV[4] ($/ac)	ROR[5] (%)	SEV[3] ($/ac)	AEV[4] ($/ac)	ROR[5] (%)
1 N		35	35	30	5.13, 1.91	127	10	9.86	-8	-1	7.91	-144	-12	6.69
2 Y, 25	N	34	34	32	5.42, 2.02	148	12	10.06	12	1	8.13	-124	-10	6.92
3 Y, 16, 25		33	32	35	5.72, 2.13	147	12	9.91	11	1	8.11	-125	-10	6.96
4 N	50 & 0[6]	34	35	30	5.13, 1.91	280	22	12.88	144	12	9.75	9	1	8.08
5 Y, 6	100 & 0[6]	34	34	32	5.42, 2.02	401	32	15.52	265	21	11.28	129	10	9.26
6 Y, 6, 25		33	32	35	5.72, 2.13	415	33	15.32	280	22	11.30	144	12	9.34
7 Y, 6, 16, & 25	100 & 50[7]	32	31	37	6.09, 2.27	496	40	16.89	360	29	12.22	225	18	10.06

Table 9. A comparison of **loblolly pine plantation** management scenarios[1] under a **33-year rotation** with thinning in years 15 and 24 and their effect on economic variables, with site prep and plant (SP&PL) cost of **$125, $250, and $375/acre**.

Treatments						SP&PL @ $125			SP&PL @ $250			SP&PL @ $375		
Scenario # Fert. @ yr.	Pine straw ($/ac)	% PW	% CNS	% St	MAI[2] Ton, Cord	SEV[3] ($/ac)	AEV[4] ($/ac)	ROR[5] (%)	SEV[3] ($/ac)	AEV[4] ($/ac)	ROR[5] (%)	SEV[3] ($/ac)	AEV[4] ($/ac)	ROR[5] (%)
1 N		34	36	29	5.34, 2.15	176	14	10.41	40	3	8.42	-96	-8	7.18
2 Y, 25	N	34	34	32	5.81, 2.34	195	16	10.47	59	5	8.57	-77	-6	7.38
3 Y, 16, 25		33	32	35	6.30, 2.54	246	20	10.94	110	9	9.02	-26	-2	7.80
4 N	50 & 0[6]	34	36	29	5.34, 2.15	328	26	13.35	193	15	10.20	57	5	8.52
5 Y, 6	100 & 0[6]	34	34	32	5.81, 2.34	447	36	15.66	312	25	11.56	176	14	9.59
6 Y, 6, 25		33	32	35	6.30, 2.54	514	41	16.26	379	30	12.12	243	19	10.10
7 Y, 6, 16, & 25	100 & 50[7]	32	31	37	6.65, 2.68	589	47	17.31	453	36	12.81	318	25	10.67

[1] Uninflated, 8% discount rate, before taxes, GaPPS v 4.20.
[2] MAI = Mean Annual Increment of wood growth for 33 yrs., tons & cords/A/yr.
[3] SEV = Soil Expectation Value, calculated from perpetual rotations
[4] AEV = Net Annual Equivalent Value, net present worth as an annuity.
[5] ROR = Rate of Return (percent)
[6] With thinning, pinestraw raked years 8-14.
[7] With thinning, pinestraw raked years 8-14 and 17-23.

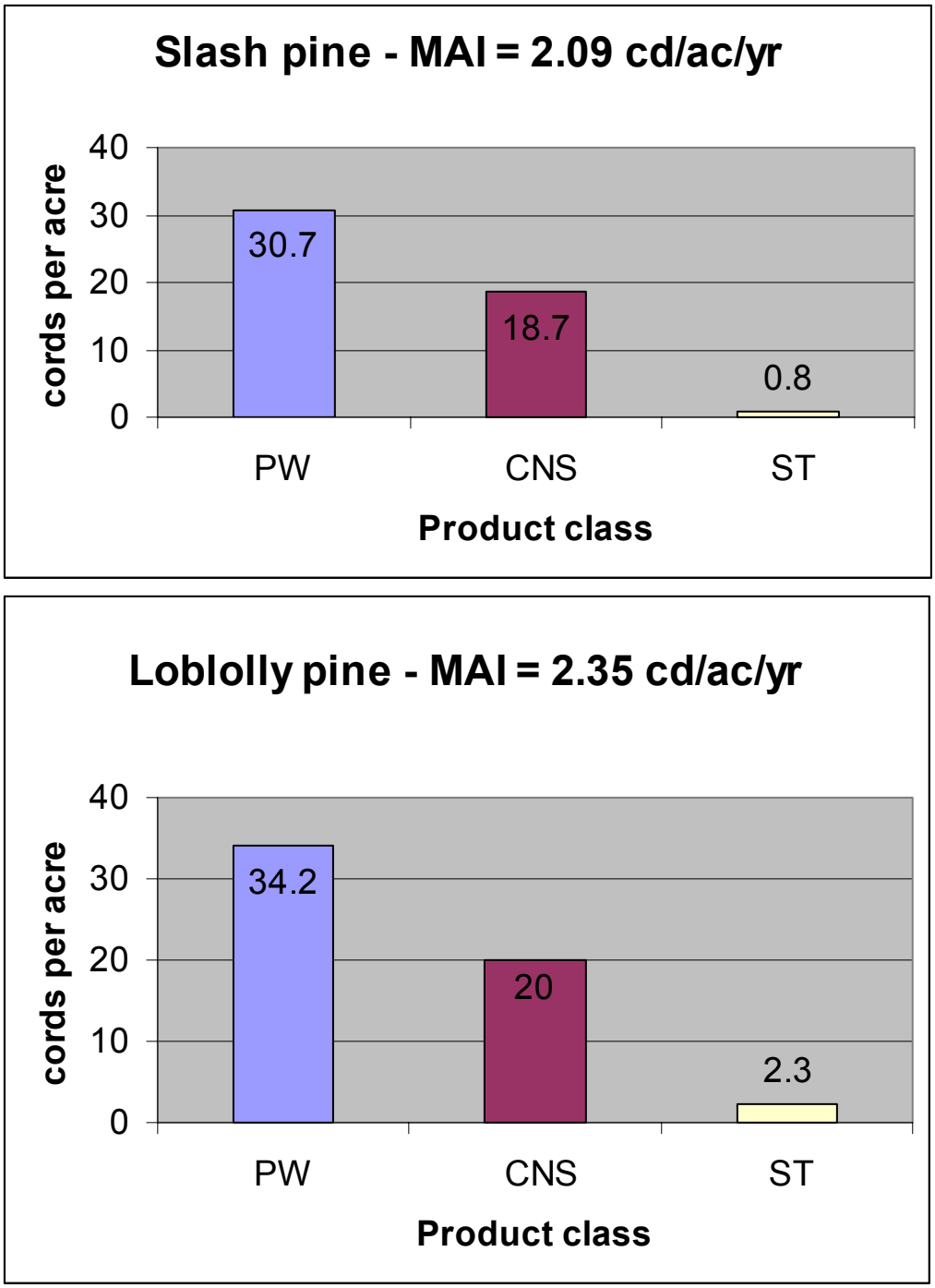


Figure 1. Slash and loblolly pine 24-year rotation wood flow for scenario #1; no thin, no fertilization, and no pine straw. (PW=pulpwood; CNS=chip-n-saw; ST=sawtimber; MAI=mean annual increment)

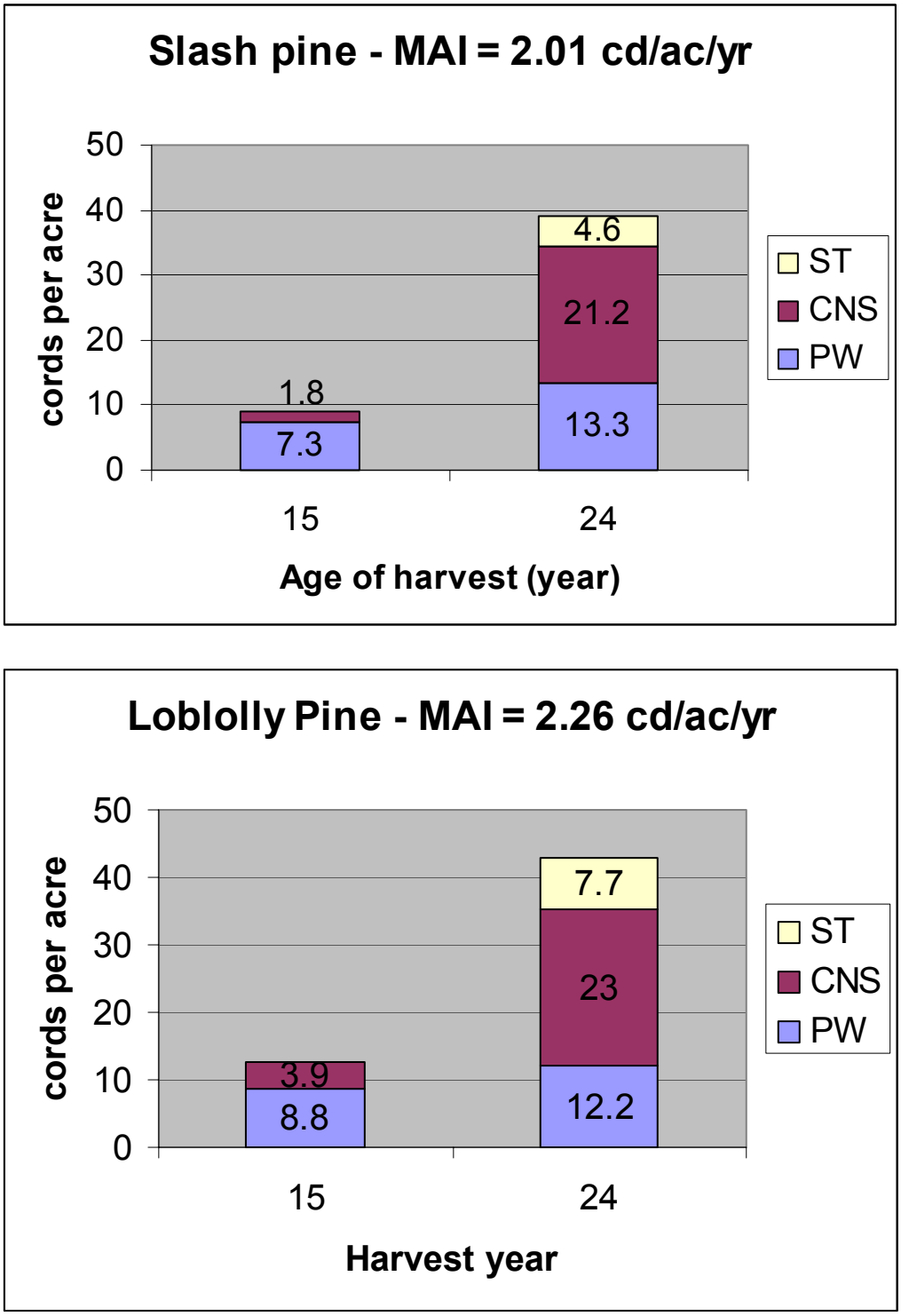
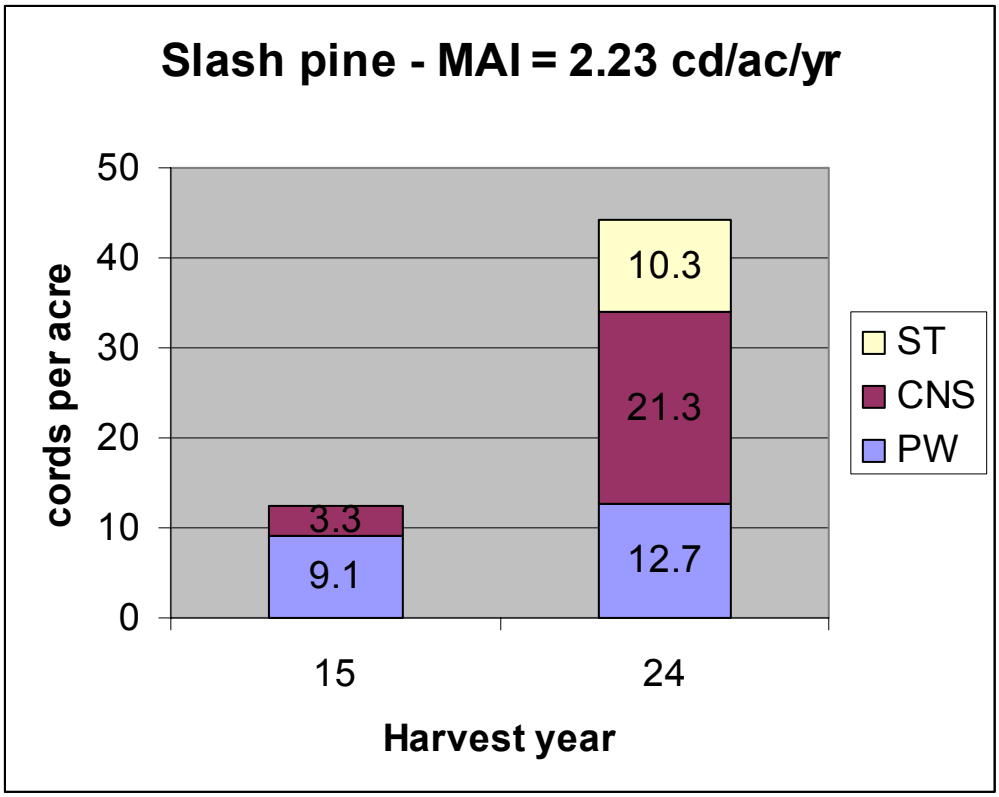


Figure 2. Slash and loblolly pine 24-year rotation wood flow for scenario #2; one thin, no fertilization, no pine straw. (PW=pulpwood; CNS=chip-n-saw; ST=sawtimber; MAI=mean annual increment).



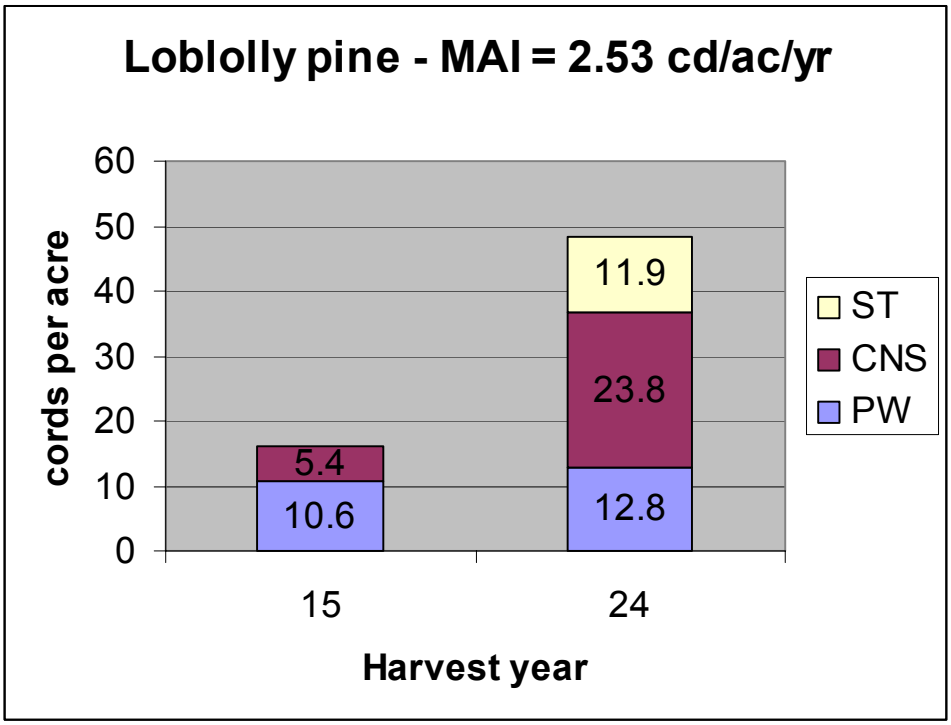


Figure 3. Slash and loblolly pine 24-year rotation wood flow for scenario #6-8; one thin, one fertilization, with and without pine straw. (PW=pulpwood; CNS=chip-n-saw; ST=sawtimber; MAI=mean annual increment).

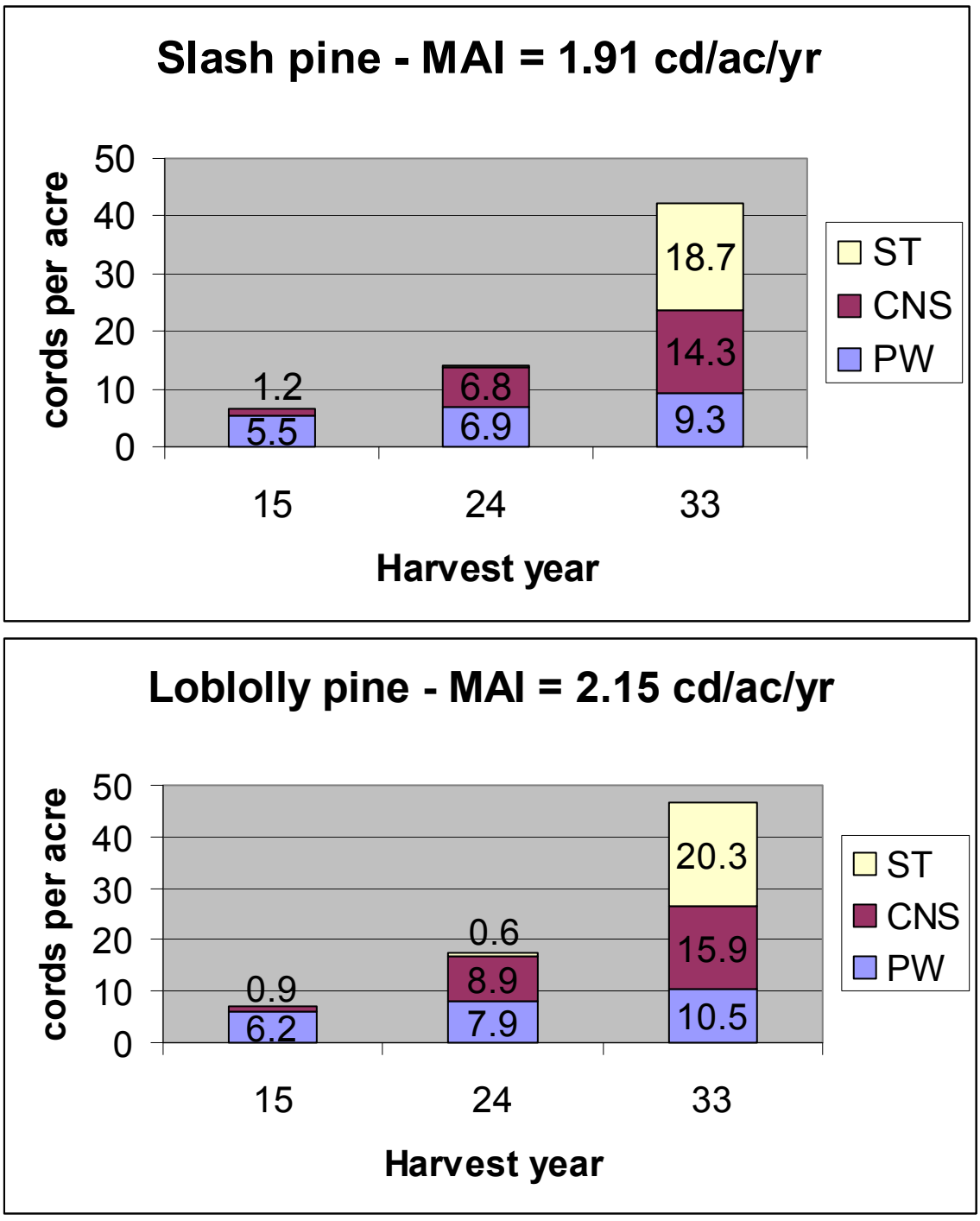


Figure 4. Slash and loblolly pine 33-year rotation wood flow for scenario #1 and #4. (PW=pulpwood; CNS=chip-n-saw; ST=sawtimber; MAI=mean annual increment).

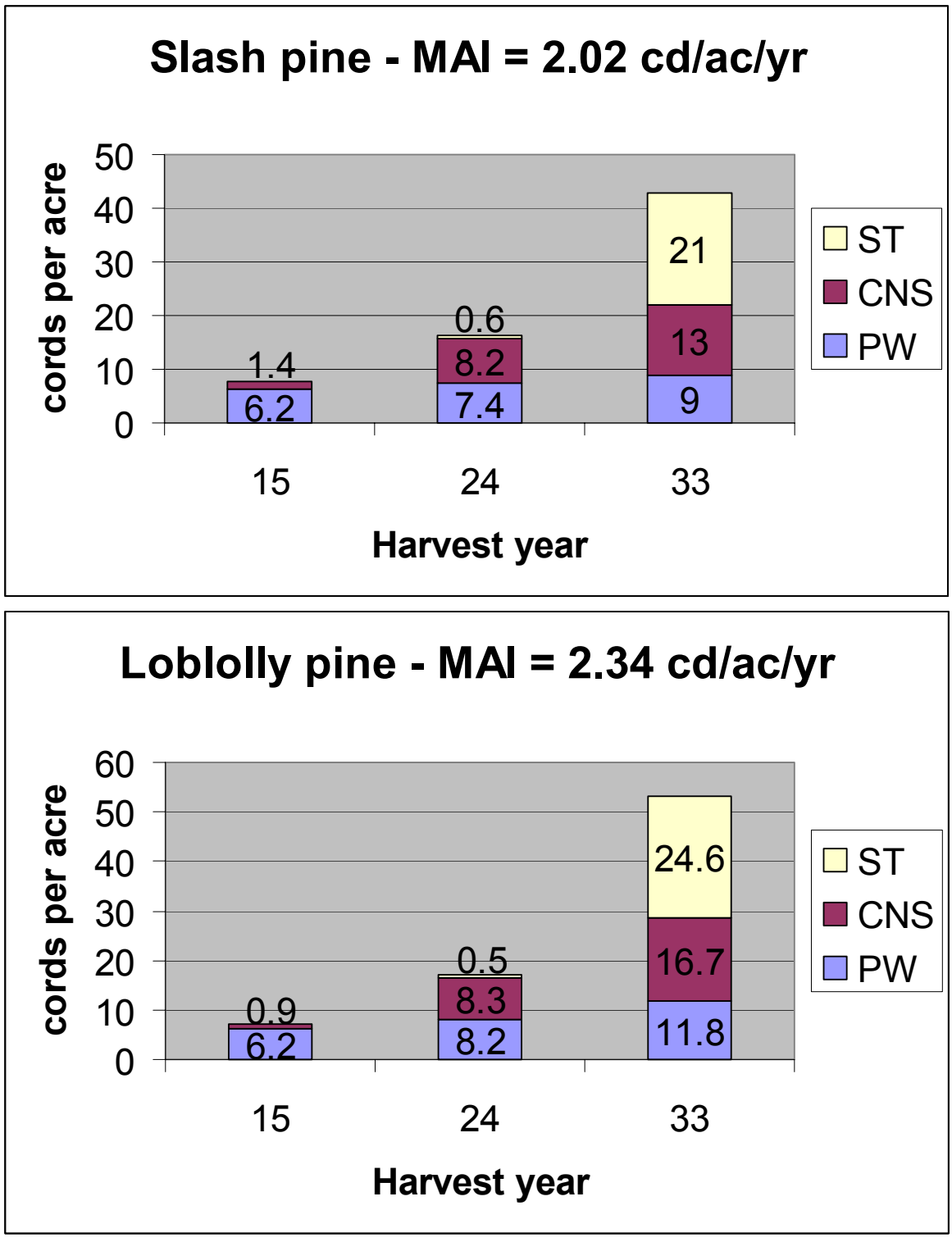


Figure 5. Slash and loblolly pine 33-year rotation, fertilized at age 25-years, wood flow for scenario #2 and #5. (PW=pulpwood; CNS=chip-n-saw; ST=sawtimber; MAI=mean annual increment).

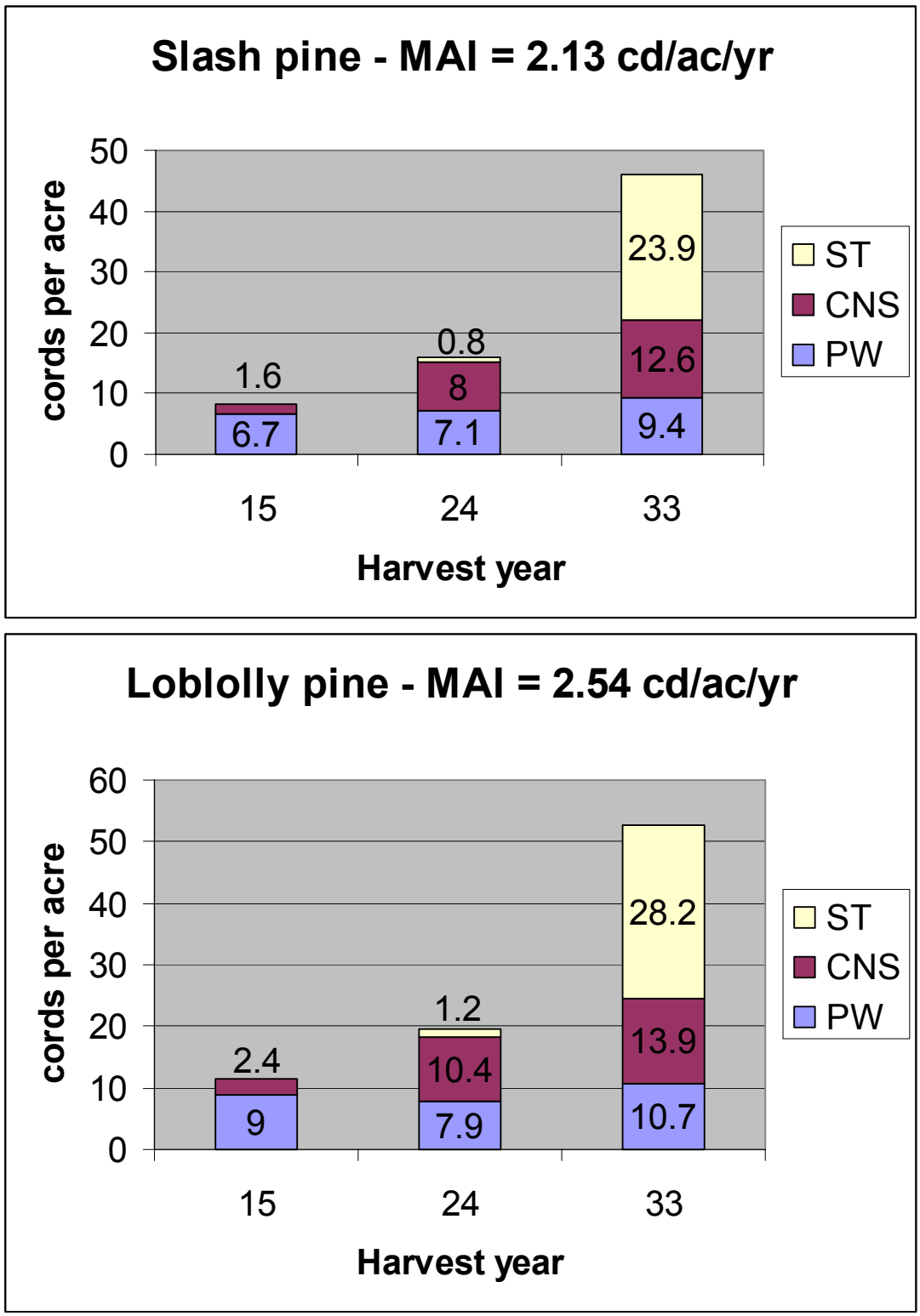


Figure 6. Slash and loblolly pine 33-year rotation wood flow for scenario #3 and #6. (PW=pulpwood; CNS=chip-n-saw; ST=sawtimber; MAI=mean annual increment).

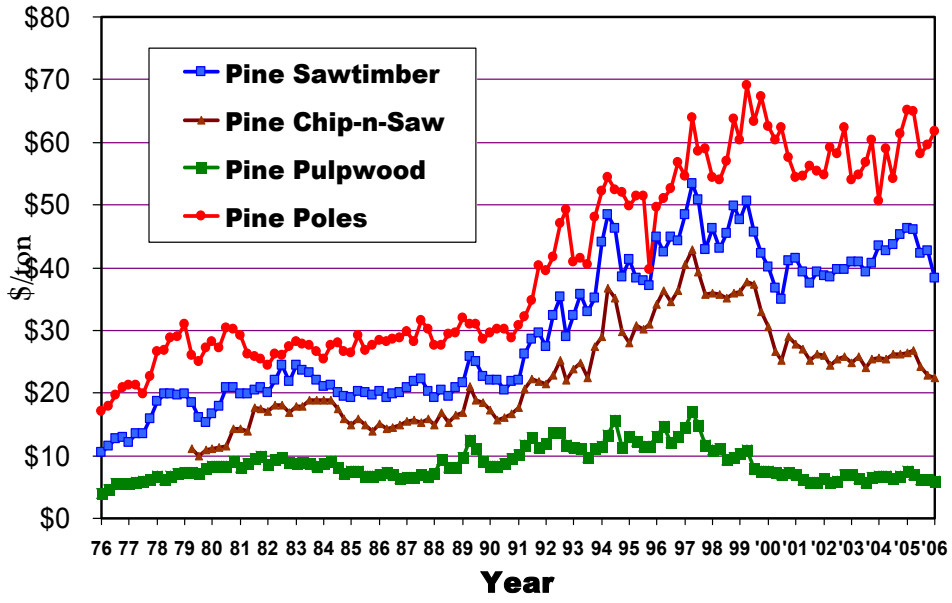


Figure 7. Pine stumpage prices for Georgia from 1976 through 2006 (TM-S 2007).