Series Paper #2

Economics of growing slash and loblolly pine to a 24-year rotation with and without thinning, fertilization, and pine straw production – soil expectation value and annual equivalent value

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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 short-rotation management options affecting wood-flow for slash and loblolly pine plantations including thinning, fertilization, and pine straw harvests under alternative levels of productivity, establishment costs, and product prices. Financial measures of profitability calculated in this series paper include soil expectation value (SEV) and annual equivalent value (AEV). Financial measures of profitability calculated in series paper #1 include net revenues 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 slash or loblolly pine on cut-over and old-field sites. They also question spending moderate to relatively large sums of money in intensive forest management 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 majority of the stand and tree data to develop the GaPPS growth and yield models for slash and loblolly were in the 10 to 25-years age classes. Therefore, we used a 24-year rotation age that had a mixed product class distribution of pulpwood (PW), chip&saw (C-N-S) and sawtimber (ST). Generally, culmination of merchantable volume mean annual increment occurs for both species on average to good sites and management in the early 20-years (Pienaar and others 1996). Longer rotation ages are often financially attractive, which we address in companion papers in this series of economic manuscripts.

Methodology

Common assumptions

The rotation age was set at 24-years for slash and loblolly pine plantations. A discount rate of 8 percent was used to calculate soil expectation value (SEV) and annual equivalent value (AEV). 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 cost for each year of the rotation was $9/acre. This value 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. Results are reported in constant dollars, before taxes. It is assumed that land is already owned.

Site Preparation and Planting Costs

Three site preparation and planting (SP+PL) costs rise in increments of $125/acre ($125, $250 and $375/acre). These costs represent the following site preparation and planting scenarios:

► The lower 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 machine or hand planting on a cutover site.

► The more moderate ($250/acre) establishment cost could include a burn, mechanical site prep treatment, 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 matched the level of competition control needed so that wood-flows were comparable within site productivity levels, after site preparation and planting.

Product class specifications

Product class specifications are:

► pulpwood (PW) at a d.b.h. of 4.6 to 9 inches to a 3 inch top;
► chip-n-saw (CNS) at a d.b.h of 9 through 12 inches to 6 inch top; and,
► sawtimber (ST) with a d.b.h greater than 12 inches to a 10 inch top (inside bark) were assumed (Table 1).

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, CNS, and ST are used for the clearcut. Cash and net converted prices are found in Table 2.

Species-specific assumptions
The slash pine scenarios assumed 500 living trees per acre (TPA) at age 5-years-old. A base mean annual increment of 2.09 cd/ac/yr (5.77 tons/ac/yr) @ age 24-years-old without fertilization and thinning was assumed (Table 6). The base slash scenario woodflow was approximately 15 percent less than base loblolly woodflow (Shiver and others 1999) at age 24-years. The assumed fertilizer applications will conservatively increase merchantable volume by 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 is assumed to be 500 TPA at age 5-years-old. The base mean annual increment for loblolly is assumed to be 2.35 cds/ac/yr (6.48 tons/ac/yr) (Table 7) through age 24-years-old without fertilization or thinning. The base loblolly woodflow is approximately 15 percent greater than the slash base woodflow (Shiver and others 2000) at age 24-years. The assumed fertilizer applications will conservatively increase merchantable volume by 0.65 cd/ac/yr (1.79 tons/ac/yr) for eight to ten years (NCSUFNC 1998).

Scenarios
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 an RBA of 65 ft^2/ac), no pine straw, no fertilization ,
(3) no thin, fertilize at age 16-years, no pine 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 pine straw,
(7 and 8) thin, fertilize at age 6-years, and rake pine 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.

Forest management activities
Thinning
The thinning scenarios include no thinning or one thinning at 15-years-old (scenario # 2 and 6-9, Tables 6 and 7). Total woodflow of scenario with thinning is approximately 95 percent of total woodflow of scenario without thinning for slash and loblolly without

fertilization. Residual basal area (RBA), after thinning (5th row with selection from below) is set at 65 sq. ft/acre.

Fertilization

A fertilizer and application cost of $100/acre for slash and loblolly per application at age 6-years and/or 16-years-old were assumed. Fertilization with 150 then 200 N + 40 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 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 expenses (Table 3).

Scenarios with fertilization for both loblolly and slash pine were set-up as follows: (#3) to delay fertilization cost (age 16-yrs only), (#4) to maintain or enhance pine straw production from canopy closure (age 6-yrs only), (#5) to maintain pine straw production (age 6- and 16-yrs) through the rotation with a higher annual revenue, (#6) to change product class distribution and put extra growth on best trees after thinning (age 16-yrs only), (#7 and #8) to maintain or enhance pine straw production from just prior to canopy closure (age 6-yrs only) to the first thinning, and (#9) to maintain or enhance pine straw production from just prior to canopy closure (age 6-yrs) to the first thinning and to change product class distribution and put extra growth on best trees after thinning (age 16-yrs, Tables 6 and 7).

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 raking starts 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 5). Scenarios that included pine straw income for both species are #'s 4, 5, and 7-9 (Table 6 and 7).

Results

Soil expectation value (SEV) and annual equivalent value (AEV) ranges

SEV for all scenarios (54 scenarios in all) for both species ranged from -$225 and -$175/acre (slash and loblolly scenario #1 with highest SP+PL cost/acre, respectively) to +$689 and +$782/acre (slash and loblolly pine scenario #5 with the lowest SP+PL cost, respectively) using the aforementioned assumptions (Tables 6 and 7). AEVs ranged from -$18 and -$14/acre/yr (slash and loblolly scenario #1 with highest SP+PL cost/acre, respectively) to +$55 and +$63/acre/yr (slash and loblolly pine scenario #5 with the lowest SP+PL cost, respectively).

Impact of thinning on SEV and AEV

Thinning slash and loblolly pine stands increased SEV by $98 to $99/acre (slash, Table 6) and by $125 to $126/acre (loblolly, Table 7) over unthinned, unraked stands (scenario #1 vs 2). Thinning also increased AEV by $8/acre/yr (slash) and $10/acre/yr (loblolly) compared to the unthinned counterpart with no additional cost.

Impact of pine straw income on SEV and AEV

The addition of pine straw income for slash pine in the unthinned scenarios (#4 and 5) increased base scenario (#1) SEV by $296 and $297/acre (loblolly and slash pine raked @ $50/acre/yr) to $617 and $661/acre (loblolly and slash pine raked @ $100/acre/yr, Table 6 and 7). The addition of pine straw income for slash pine in the unthinned scenarios increased base scenario (#1) AEV by $23 and $24/acre/yr (loblolly and slash pine raked @ $50/acre/yr) to $49 and $53/acre/yr (loblolly and slash pine raked @ $100/acre/yr, Table 6 and 7).

In thinned slash pine stands (scenario #2), pine straw income increased SEV by $174 and $179/acre at the $50/acre/yr raking income prior to thinning (loblolly and slash scenario #7, respectively). Pine straw raking in the loblolly and slash scenario (#8) prior to thinning (age 8 through 14-years) at $100/ac/yr increased SEV by $341 and $346/acre (loblolly and slash scenario #8, respectively). The addition of pine straw income for the thinned scenarios (#2) increased AEV by $27 to $28/acre/yr (loblolly and slash pine raked @ $50/acre/yr; scenario #7) to $35 and $39/acre/yr (loblolly and slash pine raked @ $100/acre/yr; scenario #8, Table 6 and 7).

The addition of pine straw income at $100/acre/yr prior to thinning and $50/acre/yr in years 17 through 23 increased SEV by $438 and $491/acre compared to the thinned only slash and loblolly pine scenario, respectively (#2, Table 6 and 7). The addition of pine straw income at $100/acre/yr prior to thinning and $50/acre/yr in years 17 through 23 increased AEV by $35 and $39/acre/yr compared to the thinned only slash and loblolly pine scenario, respectively (#2, Table 6 and 7).

Impact of fertilization on SEV and AEV

Fertilization in the unthinned stand scenarios with 200 N + 40 P/acre at age 16-years-old ($100/ac cost in yr 16), increased SEV by $72 to $73/acre across the three SP+PL levels (scenario #1 vs #3, Table 6 and 7). Fertilization at age 16-years SEV (scenario #3) was $26 and $54/acre below the thin only scenario for slash and loblolly pine, respectively (#2, Table 6 and 7).

Fertilization at age 16-years in the unthinned stands (scenario #3) increased AEV by $6/acre/yr compared to the unthinned unfertilized scenario (#1) for loblolly and slash pine. The AEV for the thinned only scenario (#2) was $2 and $4/acre/yr greater than the fertilize at age 16-years in unthinned scenario for loblolly and slash pine, respectively (#3, Table 6 and 7).

The combination of thinning slash pine at age 15-years and fertilization at age 16-years (scenario #6) improved SEV by $66 to $69/acre over the thin only scenario (#2) for slash and loblolly pine. Thinning slash pine at age 15-years and fertilization at age 16-years (scenario #6) improved AEV by $2 to $6/acre/yr over the thin only scenario (#2) for slash and loblolly pine (Table 6 and 7).

Impact of establishment costs on SEV and AEV

The impact of establishment costs (site preparation and planting or SP+PL) within a management level (scenario) were large enough to illustrate the importance of choosing the right SP+PL for a given site. The impact of SP+PL on SEV and AEV became larger as management inputs increased for both species. For example: the base slash pine scenario (#1) of no thin, no fert, no straw had SEVs of -$225, -$76, and $72/acre at the $375, $250, and $125/acre SP+PL cost, respectively (Table 6). The base loblolly pine scenario (#1) of no thin, no fert, no straw had SEVs of -$175, -$27, and $121/acre for at the $375, $250, and $125/acre SP+PL cost, respectively (Table 7). SEVs and AEVs were greater than zero (calculated @ an 8 percent discount rate) for all scenarios for both species at the $125/acre SP+PL cost. SEVs and AEVs were positive for scenarios #2 and #4-9 for slash and #2-9 for loblolly pine at the $250/acre SP+PL cost, and scenarios #4-9 for slash and loblolly pine at the $375/acre SP+PL cost (Table 6 and 7).

The highest SEVs and AEVs for slash and loblolly pine were from scenarios #5, then #9, then #8 (Table 6 and 7). The impact of SP+PL in the loblolly scenarios showed the same trend as the slash pine scenarios.

Impact of management inputs on SEV and AEV

Generally, increasing management, whether through a thinning or with fertilization or clean-up for pine straw after a thinning with their associated costs, increased SEV and AEV for both species. Thinning (scenario #2) improved SEVs by $98 (slash) and $126/acre (loblolly) and AEVs by $8 and $10/acre/yr over the unthinned scenario (#1, Table 6 and 7). The exception was scenario #3 (fert @ age 16-yrs, no thin, no pine straw). SEVs for scenario #3 for slash (Table 6) and loblolly (Table 7) were lower by

$26 (slash) and $53/acre (loblolly) and AEVs were lower by $2 and $/acre/yr than scenario #2 (no fert, thin, no pine straw).

Adding pine straw income (@ $50/acre/yr) in unthinned stands improved SEVs by $297/acre for both species and AEVs by $23 to $24/acre/yr (scenario # 4 vs 1, Table 6 and 7). The $100/ac/yr pine straw revenue from age 8- through age 23-years improved SEVs by $617 (slash) and $661/acre (loblolly) and AEVs by $41 and $43/acre/yr over the no rake, unthinned scenario (#5 vs #1).

Summary

Wood flow, fertilization responses, and pine straw

The 2.01 (5.77 tons/ac/yr) to 2.48 cords/acre/yr and 2.26 (6.48 tons/ac/yr) to 2.88 cords/acre/yr productivity levels at age 24-years-old 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. Exceptions would be problem soils such as deep sands (Typic Quartzipssamments) of the Sand Hills or shallow, rocky soils of the Piedmont physiographic region.

These scenarios do illustrate that if the aforementioned growth rates for slash and loblolly pine were assumed then the establishment expenditures (site preparation and planting costs) need to be used wisely. In many cases, the establishment phase decisions (site preparation type, timing, and quality, site preparation effects on near- or long-tern site productivity, woody and herbaceous weed control efficacy, species selection, seedling genetics and size, seedling survival) can improve growth rates above those used here, therefore improving net revenues, SEV, AEV, rates of return.

The 0.50 cd/ac/yr (1.38 tons/ac/yr) for slash and 0.65 cds/ac/yr (1.79 tons/ac/yr) for loblolly average increase in wood production is consistent with published reports (Jokela and Stearns-Smith 1993, Martin and others 1999, NCSFNC 1999) with nitrogen plus phosphorus fertilization at ages 6- and 16-years. None the less, the assumed response to fertilization will only occur on those sites where N or N and P are deficient, pine stocking is not over- or under-stocked, and pine stand genetic quality will allow for a large response to fertilization. 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 on marginal fertility soils. Fertilization was included in the pine straw production scenarios to maintain straw production as nutrients are removed/displaced with each raking.

When wood value only is considered, loblolly produced more wood, more wood value, a higher SEV and AEV with the aforementioned assumptions. Recent studies (Shiver and others 1999) have shown that loblolly will grow more wood than slash on a number of soils where both species are grown. Loblolly's superior wood volume yields do not necessarily equate to higher per acre or per unit wood stumpage prices. Clark (2002) noted that slash pine yielded more number one lumber, had a slightly greater (4 to 11 percent greater) density, and 4 percent less moisture content than loblolly pine in growing in the same stand.

Discussion

Non-industrial private forest landowners do have some attractive forest management options with both slash and loblolly pine even when using low to medium stumpage prices (TM-S 2004). Generally, increasing forest management activities (thinning, fertilization, adding pine straw) increased SEVs and AEVs at the wood growth increments used.

Positive SEVs and AEVs (using an 8 percent discount rate) were achieved at the lowest site preparation and planting establishment cost with the stumpage prices used (Georgia 1st Qtr 2004, TM-S 2004) and with wood production rates of 2.01 to 2.88 cords/acre/yr, in all 9 scenarios for both species. Positive SEVs and AEVs were realized at the moderate SP+PL level in the thin scenario (#2) through scenario #9 for both loblolly and slash pine. At the highest SP+PL level, positive SEVs and AEVs were achieved only when pine straw pine straw income @ $50/ac/yr or better was realized for slash pine (scenarios 4, 5, 7-9, Table 6 and 7). The thin and fetilize at age 16-years scenario (#6) and the pine straw scenarios (scenarios #4,5, and 7-9) for loblolly pine at the highest SP+PL level also had positive SEVs and AEVs.

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Table 1. 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 2. 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).

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 3. Fertilizer costs at $100/acre expressed as present values and annual equivalent values (AEV), as used in the profitability analysis for 24-year slash and loblolly scenarios calculated 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

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 a 24-year rotation calculated at 8%.

Rotation	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

[1] With thinning, pine straw raked in years 8-14, for 24-year rotation.
[2] With thinning, pine straw raked in years 8-14 and 17-23, for 24-year rotation.
[3] With no thinning, pine straw raked in years 8-23, for 24-year rotation.

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

Rotation age	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

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)	SEV[3] ($/ac)	AEV[4] ($/ac)	SEV[3] ($/ac)	AEV[4] ($/ac)
1 N	N	N	60	5.77, 2.09	72	6	-76	-6	-225	-18
2 N	Y		46	5.55, 2.01	171	14	22	2	-126	-10
3 Y, 16	N	N	48	6.28, 2.28	145	12	-3	0	-152	-12
4 Y, 6		50[5]	52		369	29	220	18	72	6
5 Y, 6, 16		100[5]	43	6.82, 2.48	689	55	541	43	392	31
6 Y, 16	Y	N	40	6.16, 2.23	237	19	88	7	-60	-5
7 Y, 6		50 & 0[6]	43		350	28	201	16	53	4
8 Y, 6		100 & 0[6]			517	41	368	29	220	18
9 Y, 6, 16		100 & 50[7]	38	6.57, 2.38	609	49	461	37	312	25

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)	SEV[3] ($/ac)	AEV[4] ($/ac)	SEV[3] ($/ac)	AEV[4] ($/ac)
1 N	N	N	60	6.48, 2.35	121	10	-27	-2	-175	-14
2 N	Y		46	6.24, 2.26	247	20	99	8	-50	-4
3 Y, 16		N	48	7.15, 2.59	194	16	45	4	-103	-8
4 Y, 6	N	50[5]	52		418	33	270	22	122	10
5 Y, 6, 16		100[5]	43	7.94, 2.88	782	63	633	51	485	39
6 Y, 16		N	40		316	25	167	13	19	2
7 Y, 6	Y	50 & 0[6]	43	6.99, 2.53	421	34	273	22	125	10
8 Y, 6		100 & 0[6]			588	47	440	35	292	23
9 Y, 6, 16		100 & 50[7]	38	7.68, 2.78	738	59	589	47	441	35

[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] With no thinning, pinestraw raked years 8-23.
[6] With thinning, pinestraw raked years 8-14.
[7] With thinning, pinestraw raked years 8-14 and 17-23.