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Silvicultural Guidelines For Pinestraw Management In The Southeastern United States

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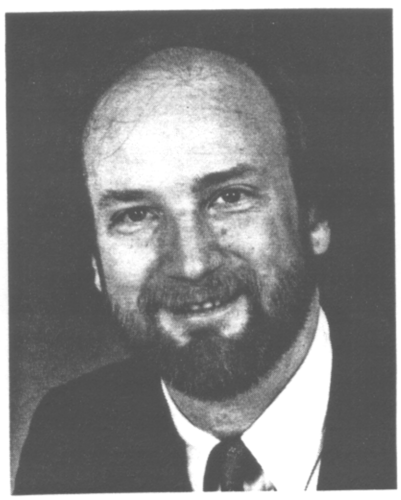

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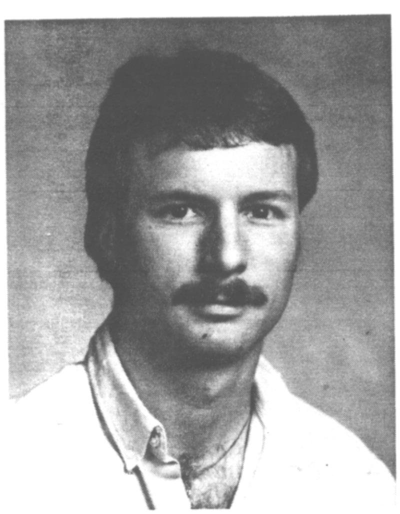

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Silvicultural Guidelines For Pinestraw Management In The Southeastern United States

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Figure 1: Pinestraw is commercially baled using either a box-baler (left) or a modified hay baler (right). Note the stack of loose pinestraw ready for baling.

Background

The increasing popularity of natural landscaping in urban and suburban areas has resulted in the rapid development of a business centered on procurement and harvest of longleaf, slash and loblolly pinestraw. In North Carolina, where the industry has the longest history, pinestraw harvesting has been estimated to be a 50 million dollar per year industry (Anonymous 1987). Southwide, revenues from this industry may exceed 150 million dollars per annum. This industry can be expected to grow for two reasons. First, few materials can compete with pinestraw for landscaping uses. It is attractive, easy to work with and stays in place when used in slope positions. Second, use of pinestraw mulch in landscaping is expected to increase as water use restrictions are enacted by state and local governments, and water efficient landscaping (xeroscaping) is encouraged.

Pinestraw falls from southern pines at all times during the year and, therefore, pinestraw harvesting is a year-round business. Pinestraw producers fall into three categories, 1.) those who rake, bale and sell directly to the retailer, 2.) those who rake and bale for a wholesaler and 3.) those who rake and sell straw on a retail level. Most pinestraw is processed by large producers in the first two categories, but some straw is raked and sold by small, independent operators. Methods of collection and baling pinestraw vary, ranging from completely mechanized collection and machine baling to hand-raking and box-baling (Fig. 1).

Pinestraw is purchased both on a price-per-bale and a lump sum price-per-acre basis; the method of purchase varies depending on location and individual contractors. There are advantages and disadvantages to each method. Purchase of pinestraw on a price-per-acre basis has the advantage of providing the landowner with exact *a priori* revenues to be expected from the harvesting operation. Sale by this method requires accurate assessment of potential yield in bales-per-acre from the area. Few landowners have such expertise and they must depend on estimates of yield supplied by the producer. In areas where estimates are available from a number of producers, fair value will be received for the pinestraw, and this method of sale is acceptable. Sale on a price-per-bale basis has the advantage of providing exact revenues for the pinestraw removed. Also, the landowner can develop a system to independently check bale removal to avoid theft. Major disadvantages to this method are that producers will be tempted to rake only the most accessible areas of a stand and they have less incentive to work with the landowner to improve stand conditions and pinestraw harvest. Ultimately, no method is necessarily better; both depend on working with reputable and experienced producers. Silvicultural operations are most easily evaluated in terms of additional bales produced and, for this reason, it may be preferable to sell pinestraw on a price-per-bale basis.

The retail value of baled pinestraw ranges from an average of $3.50 in Atlanta, GA to $5.00 in Jacksonville, FL, with individual prices ranging from a low of $2.98 to a high of $7.99/bale[1]. Harvesting and transportation costs are a major portion of these retail costs. Typically, a landowner receives from $0.40 to $1.00 per bale of straw, the harvesting contractor makes $0.75 to $1.00/bale profit and the retail outlet makes from $0.75 to $1.50 bale profit.

Pinestraw harvesting represents an attractive income opportunity in pine stands prior to commercial harvest. Annual income from pinestraw harvest shortens the period over which initial investments in regeneration must be held, and provides a source of income for intermediate silvicultural treatments such as thinning, competition control and fertilization, which can increase the value of final timber harvests. In certain cases, pinestraw may actually represent the primary product for which a stand is managed and wood is a secondary product.

Despite the potential benefits afforded by pinestraw harvest, there is concern that it may have detrimental impacts on forest stand growth. Pinestraw plays an important role in maintaining tree growth on relatively infertile soils that support southern pine forests. Each year a major portion of the nutrients absorbed by a stand of trees is returned to the soil in pinestraw. As these pine needles decompose, the nutrients they contain become available for root uptake to support further growth (Switzer and Nelson 1972, Jorgensen and Wells 1986). Thus, nutrients are "reused" a number of times during the growth cycle of a forest stand. When pinestraw is raked, this cycle is interrupted and tree growth can be reduced. Pinestraw also has an important effect on soil moisture. Although pinestraw may intercept some rainfall and keep if from entering the soil, it more often serves as a water conserving mulch. Its removal can increase tree water stress on dry sites (McLeod et al.1979, Ginter et al. 1979).

An accurate assessment of financial and biological aspects of pinestraw harvesting cannot be made without information on changes in stand growth associated with pinestraw removal. Unfortunately, little information on growth responses to pinestraw removal or to silvicultural treatments that may be utilized in a pinestraw management program is available. We believe that, with suitable management, many sites can be managed for pinestraw production while maintaining or improving stand growth. In this report, we present preliminary guidelines for pinestraw management.

[1]Telephone survey conducted in mid-February 1991 of major home and garden centers in Atlanta, Birmingham, Charlotte, Jacksonville, New Orleans, and Raleigh.

Pinestraw Production and Nutrient Removal

Annual pinestraw production within the southeastern United States depends upon many factors, among which stand age, species and site fertility are dominant. Previous research has demonstrated that, for unfertilized southern pine stands (loblolly, slash, longleaf), needlefall amounts increase with stand age until about age 15 years when needle biomass production approaches an annual maximum (Switzer and Nelson 1972; Wiegert and Monk 1972; Gresham 1982; Gholz et al. 1985). During that period, needles constitute approximately 75 to 90% of total litterfall mass because significant branch and bark shedding has not begun.

Expected pinestraw production rates for young and semimature stands is closely correlated with stand basal area (Fig. 2). For young-fully stocked slash pine plantations, for every 18 ft^2ac^{-1} of cumulative basal area, pinestraw production increases by about 900 lbs ac^{-1} up to an annual maximum of about 4,500 lbs ac^{-1}. Similarly, with loblolly pine, pinestraw production will reach some upper level (4,500-5,000 lbs ac^{-1}) when stand basal area approaches 100 to 110 ft^2ac^{-1}. For less intensively managed mature plantations and mixed stands, rates are lower for a given basal area. Fig. 2 can be used by practitioners as a general guide for estimating needlefall in managed plantations and natural southern pine stands.

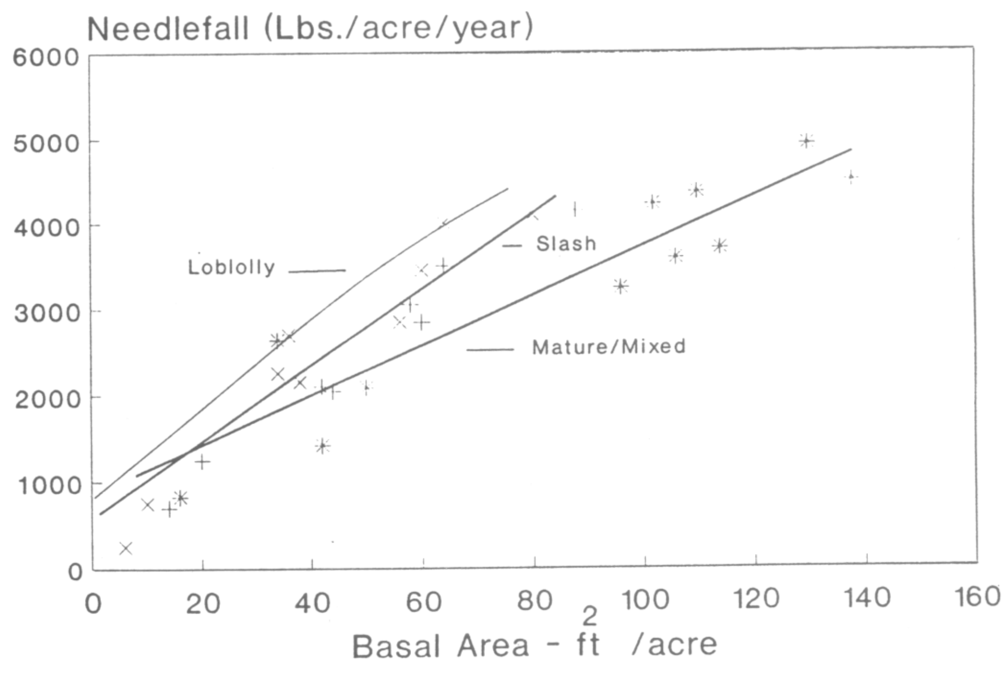

Figure 2: Relationships between annual pinestraw production (litterfall) and basal area in experimentally established slash and loblolly pine plantations and in mature stands of southern pine. Data plotted from Dalla-Tea and Jokela 1991 and Gresham 1982.

The annual pinestraw production values presented in Fig. 2 represent the upper biological limits for annual removal for these species. Pinestraw removal during commercial harvests will be lower because not all of the surface is actually raked due to the presence of understory plants, overstory hardwoods or debris. Results from a survey of pinestraw removal during commercial pinestraw harvesting operation in Georgia are presented in Table 1. On average, about 75% of the surface is raked during these operations, removing about 2500 lbs/acre (142 bales/acre) of pinestraw. The relationship between *actual* pinestraw removal and stand basal area is poor (Fig. 3). Differences in recovery and period of straw accumulation since the last disturbance contribute to this variability, as do differences in site quality, tree vigor, tree species and age.

Nutrient removals associated with pinestraw harvesting vary from site to site, and are largely a function of the proportion of harvestable area, and site and stand conditions which affect pinestraw production. Removals in any single harvest are not large, ranging from 5-60 lbs/acre for nitrogen, 0.5-5.0 lbs/acre for phosphorus, 0.5-29 lbs/acre for potassium, 3-21 lbs/acre for calcium and 0.75-5.0 lbs/acre for magnesium (Table 1). Low phosphorus and potassium removals are partially due to low concentrations resulting from leaching of these nutrients from the pinestraw by rainfall prior to harvest (Duffey and Schreiber 1990). Potentially, removal of nutrients in loblolly pinestraw are greater than removals in either slash or longleaf pine because of 1.) greater nutrient requirements and higher foliage nutrient concentrations (Polglase *et. al.*1992, 2.) greater needle production (see Fig. 2) and 3.) higher overall fertility of sites where loblolly pine commonly occurs.

Although nutrient removals in a single harvest are small, they become significant in stands repeatedly raked (Fig. 4). For instance, annual raking in a slash pine plantation beginning at age 10 years would remove about 225 lbs/acre of nitrogen, 16 lbs/acre of phosphorus, 13 lbs/acre of potassium, 104 lbs/acre of calcium and 25 lbs/acre of magnesium from an "average" stand prior to harvest at age 22. These removals exceed those calculated for complete above-ground harvest of all trees. For nitrogen, phosphorus and potassium, these removals are two- to four-fold greater than removals in harvest of merchantable portions of the stems (Neary et al. 1984). Removals of calcium and magnesium are about equal to removals in merchantable stem harvest.

Selecting Sites for Pinestraw Production

Stand Conditions

At present, few differences exist in bale price at either the wholesale or retail level for pinestraw from loblolly, slash or longleaf pine. As customer experience increases, and more suitable land become available for pinestraw harvest, a differential is expected to develop. Straw from longleaf pine will likely command a higher price than slash or loblolly pine for landscaping purposes, as straw from this species is of greater length and retains its reddish-brown color longer than needles from slash or loblolly pine. Loblolly pinestraw does provide a better mulch for use around vegetable crops and, in many areas, will remain equally as marketable.

To be marketable, pinestraw must be free from hardwood leaves, understory vegetation, and large numbers of twigs and pine cones. Fully-stocked stands with a

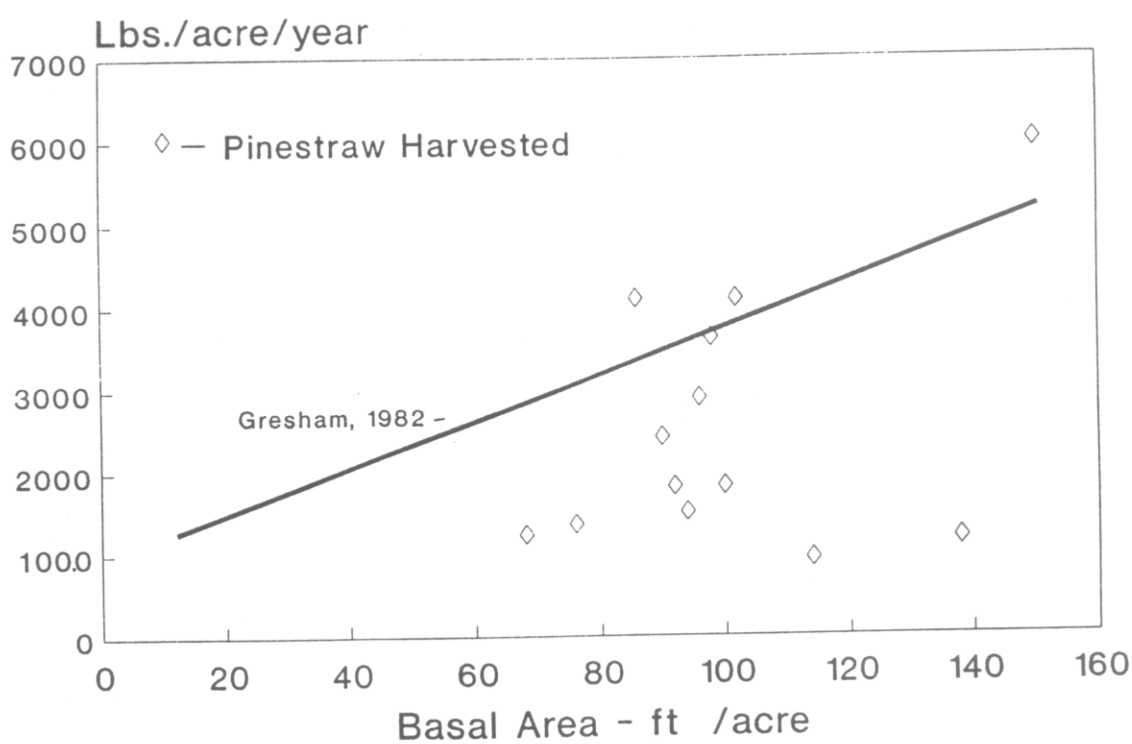

Figure 3: The relationship between pinestraw removal in commercial harvesting operations and stand basal area. Line is for pinestraw production for mature stands (data of Gresham 1982) from Fig. 2.

closed crown and non-existent understory are ideal for pinestraw harvesting. While it is possible to rake pinestraw in stands having an understory of grass (particularly wiregrass), it cannot be easily accomplished in areas containing litter from broad-leaved vegetation.

Forest stands in which pinestraw is commercially harvested fall mainly into two categories: mature stands of naturally regenerated longleaf or mixed longleaf-slash pine and intensively managed slash and loblolly pine plantations. Most raking in natural stands is done by hand, avoiding areas with excessive understory vegetation. Pinestraw is harvested in plantations both by hand and machine raking. Harvesting can begin as soon as the tree canopy closes and understory vegetation is eliminated. This can occur as early as age 8 and can continue until the first thinning or harvest.

Soil Factors

Three soil factors affect site suitability for pinestraw harvesting: erosion potential, susceptibility to compaction, and reductions in fertility.

Erosion Potential. Removal of pinestraw at 2 to 3 year intervals is unlikely to increase soil erosion because the layer of partially decomposed and fragmented needles remains largely intact. More frequent removal of fresh pinestraw eliminates the source of material which maintains this soil cover and will result in exposure of mineral soil within a few years. Because of this, only sites with low erosion potential belong in intensive pinestraw harvesting programs. Flatwoods sites with low relief (< 2% slope) and coarse-textured surface soils are ideal from this standpoint. Similarly, upland sites with sandy or sandy loam surface soils, and slopes that are less than 8%, would be characterized as having low erosion potential.

Compaction. Any forest management operation that subjects a site to machine traffic can cause soil compaction and reduce tree growth; however, the potential for significant compaction to occur as a consequence of pinestraw harvest operations is low for several reasons. Only small, low ground pressure equipment is used and most sites where pinestraw will be harvested have coarse-textured surfaces which are relatively resistant to compaction. In addition, pinestraw is usually collected and baled only under dry conditions when soils are least susceptible to compaction. Although sites with fine-textured soils (sandy clay-loams to clay-loam) can be raked, some risk of soil damage is associated with repeated harvesting on these sites.

Soil Fertility. Few forested sites can be expected to support repeated removals of pinestraw without fertilization. With fertilization, most sites can support higher pinestraw harvests. Inherent fertility is greatest on old field sites (such as Conservation Reserve Program sites) in the Middle and Upper Coastal Plain and, from a nutritional standpoint, these sites are most suitable for pinestraw production. Because of past agricultural fertilization, potassium, phosphorus and calcium storage is high. Nitrogen is the nutrient most likely to limit growth during the first five years of an annual pinestraw production program. Cutover sites in the Middle and Upper Coastal Plain have a lower reserve from which to supply nitrogen, phosphorus, and potassium when contrasted with old-field sites in the same area, and will benefit from fertilization with these elements. Flatwoods sites are inherently less fertile than

Table 1. Pinestraw and nutrient removal during commercial pinestraw harvesting in Georgia. Mean and range indicated.

Stand Type	n	Stand Basal Area	Raked Area	Dry Bale Weight	Pinestraw	Removal	Nutrients Removed N	P	K	Ca	Mg
		-ft²-	-%-	-lbs/bale-	bales/acre	lbs/acre	lbs/acre				
Natural Slash - Longleaf	5	94 86-102	76 65-85	17.7 15.5-20.4	179 102-240	3236 1827-4109	22 14-29	1.4 .9-2.0	1.3 .7-2.9	11.1 8.3-12.9	2.8 1.5-3.7
Natural Longleaf	6	91 68-114	69 53-100	18.9 16.7-20.5	87 50-188	1633 940-3634	9 5-19	0.5 0.2-1.0	0.8 0.4-1.9	5.3 2.7-11.2	1.2 0.6-3.0
Plantation Loblolly	3	129 94-150	89 77-100	16.0 12.2-20.2	191 75-297	3201 1175-5999	32 9-60	2.6 0.5-4.8	1.5 0.8-2.8	11.4 5.0-21.4	2.6 0.8-5.0
Average	14	100	76	17.9	142	2542	19	1.3	1.1	8.7	2.1

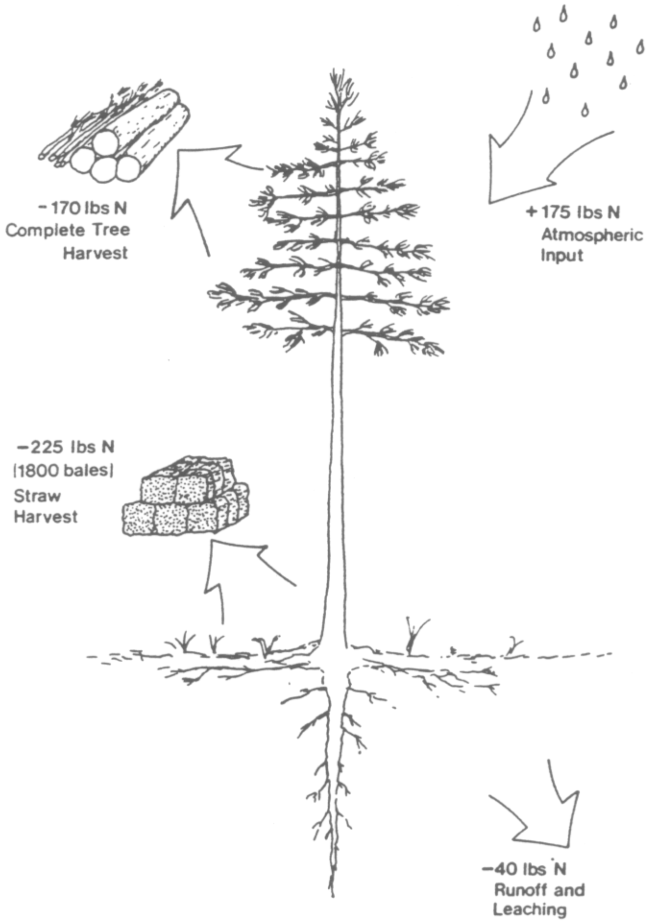

Figure 4: Nitrogen inputs and removals for a flatwoods slash pine stand from which pinestraw is removed annually beginning at age 10. All values are in lbs./acre. (Source: Gholz et al. 1985, Morris and Pritchett 1982, and present study).

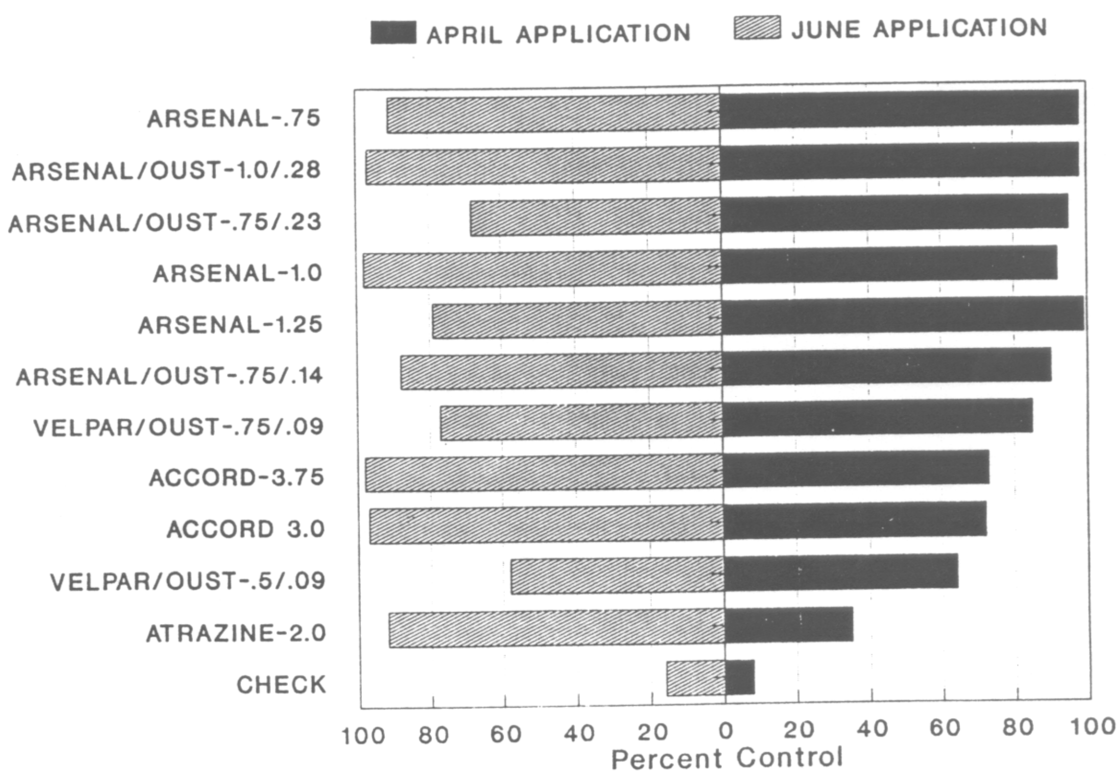

Figure 5: Effectiveness of various herbicide formulations (in lbs./acre a.i. or a.e.) for understory vegetation control in Coastal Plain slash pine. Control greater than 90% is considered adequate for pinestraw production. (Redrawn from Rivers and Edwards 1990).

Middle and Upper Coastal Plain sites and will also require additions of nitrogen, phosphorus, and potassium as part of any regular pinestraw harvesting program. Recent evidence further suggests that some flatwoods soils suffer from micronutrient deficiencies (Jokela et al. 199lb) and these will require corrective fertilization.

Those flatwoods sites characterized by soils underlain by a clay horizon (argillic) will have greater potential to retain added nutrients, and are more suitable for pinestraw harvesting than sites without such a horizon. Sandy upland sites having low organic matter (e.g. sandhills) are the most nutritionally impoverished and, thus, are the least suitable to support nutrient removals from pinestraw harvesting.

Silvicultural Options

Fertilization

Pinestraw harvesting without fertilization is not recommended for two reasons. First, in most cases, fertilization can be expected to increase straw production and stem growth. Second, without fertilization, there is a strong probability that stand growth will decline. A fertilization program for pinestraw production will closely resemble programs currently used in mangeing southern pine timberlands which include applications of various combinations of nitrogen, phosphorus and potassium. While nutritional limitations of other nutrients have been demonstrated, they are isolated and no general recommendation is appropriate.

Recommended rates and timing of fertilizer applications for pinestraw harvesting are presented in Table 2. Two general regimes are identified. The first is suitable for pine plantations from which pinestraw is annually harvested. Repeated fertilizer applications are recommended in these stands beginning at, or near, crown closure (age 8 years). Thereafter, fertilization will occur approximately every five years. The suggested application rates are based on nutrient removal estimates, inherent fertility regimes of site types within physiographic regions, and general nutrient use efficiencies of southern pines (which average about 50% of that applied). Site types associated with the second management regime, where litter raking represents a by-product of normal forest operations (i.e., raked 2-3 times only), will be fertilized once during mid-rotation. Typically, this occurs after crown closure when stands are between 8 and 12 years of age. Because tests indicate that numerous application methods (i.e., broadcast vs. banded; aerial vs. ground-based systems) are equally effective in producing growth response, factors such as equipment availability, terrain accessibility, cost, uniformity of spread, and timeliness of the operation should be considered when formulating a prescription (Jokela *et al.* 1991a).

Competition Control

Many stands not currently suited for pinestraw management can be placed into production by reducing understory competition through herbicide application, or in some instances, mowing. To be effective in a pinestraw harvesting operation, herbicide treatments should achieve 90% control of understory vegetation by October of the growing season prior to harvesting. It is not practical to expect such complete control in stands with a dense understory, and herbicide application is likely to be cost effective only in stands with low to moderate amounts of understory vegetation.

Available research on herbicide applications for pinestraw production is limited. In a study of slash pine plantations in the Coastal Plain of Georgia (Fig. 5), spring applications of ARSENAL[2] achieved control in the most cost-effective manner. In the summer, applications of ACCORD[2] resulted in the most effective control. Information on herbicide application rates and effectiveness are available from state forestry agencies and extension services. These sources should be contacted for information on available herbicides, application methods, rates, environmental considerations, and a list of recommended contractors.

Recovery of pinestraw from old-field plantations, which contain only grass or small shrubs in the understory, can be increased by mowing. Mowing should be completed after the spring growth period but well in advance of pinestraw harvesting. For example, mowing should be completed in late spring prior to fall or winter harvest.

Stand Monitoring

Little, if any, long-term data are available to predict the outcome of repeated pinestraw harvests on future site productivity. Consequently, monitoring the effects of pinestraw removal on site nutrient status and stand growth should be an integral component of a management program. The intensity of the recommended monitoring program depends on the intensity of the harvesting program. For plantations in which pinestraw is removed annually beginning at a young age, foliar analyses should be made periodically during the tree rotation in the winter prior to fertilization to assess the effects of pinestraw removal on pine nutrient status and to aid in prescribing fertilizer additions. In established stands from which pinestraw is removed only 1-3 times before tree harvest, baseline foliar analyses prior to mid-rotation fertilization should be sufficient.

Current-year pine foliar samples should be collected in January from the first growth flush of the second whorl from the apex of the crown from 10 to 15 dominant/codominant trees across the area. Needles should be removed from the branch, composited, and dried in a forced-draft oven at 70° C. Tissue samples should be analyzed for N, P, K, Ca, and Mg using a laboratory with approved methodologies. Many state laboratories provide analytical services that include an evaluation of nutritional status. Guidelines for interpreting foliage analyses are available for both slash and loblolly pine (Pritchett and Comerford 1983, Comerford and Fisher 1984, Wells and Allen, 1985).

Calculating the Returns from Silvicultural Investments

The relatively high value of pinestraw makes investment in silvicultural operations that increase straw production, or harvesting recovery and efficiency, attractive. To evaluate the value of these investments, it is important to consider:

2Does not constitute an endorsement of commercial products nor does it exempt the user from any legal obligation under federal, state or local statutes.

1. the initial cost of the investment;
2. opportunity costs associated with investing in silvicultural treatments (these costs are usually determined by selecting a real (non-inflated) rate of return for an alternative investment such as in money market funds);
3. returns on the investment from;
   a. increased/decreased pinestraw production
   b. increased/decreased wood production and value
   c. increased/decreased costs of other forest management activities (e. g. harvesting, regeneration)

As an example, consider the return on an investment in nitrogen plus phosphorus fertilization in a 17-year-old slash pine plantation on a flatwoods site (Table 3). At current prices of $175/ton for diammonium-phosphate, $180/ton for urea and ground application costs of $12.50/acre, fertilization with 150 lbs/acre N and 25 lbs/acre phosphorus will require a $54/acre investment. A second cost of $2/acre is associated with foliage sampling and analyses which we recommend as part of any pinestraw management program. Both increased pinestraw production and increased wood volume growth will generate a return from this investment. Research on fertilization response in slash pine stands indicates a median increase in straw production of about 1050 lbs./acre/year for the first 3 years following mid-rotation fertilization (N.C. State Forest Tree Nutrition Cooperative and Cooperative Research in Forest Fertilization (CRIFF) unpublished data). Assuming 75% recovery (see Table 1), this corresponds to 175 bales/acre of additional pinestraw production over the three year period. Stem volume growth can also be expected to increase. On the basis of mid-rotation fertilization trials conducted in slash pine plantations, an average increase of 2.5 cords/acre of additional volume growth can be expected by the end of the rotation for fertilized trees when compared to growth for a non-fertilized stand (Fisher and Garbett 1980, Stearns-Smith et al. 1989). The net present value of the additional income generated by the fertilization is $72 when associated costs of fertilization and nutrient monitoring are amortized at an inflation-free rate of 4%. The sensitivity of the analysis to changes in the value of additional pine straw and/or timber produced is illustrated in Fig. 6. Although fertilization is not an economically attractive investment when the net present value of additional revenue falls below fertilization costs, it may still be a worthwhile hedge against possible productivity loss.

A second example could be applied to herbicide treatments which increase harvestable area of a 14-year-old plantation from 60% to 90% and increase pinestraw recovery from 115 bales per acre to 170 bales per acre for each annual raking prior to harvest at age 22 (Table 4). An investment in herbicide application of $50/acre/treatment has a present value of $113 and generates $56 in additional income. The sensitivity of this analysis to changes in the cost of herbicide application and the value of additional straw produced is illustrated in Fig. 7.

RETURN ON INVESTMENT - FERTILIZER APPLICATION

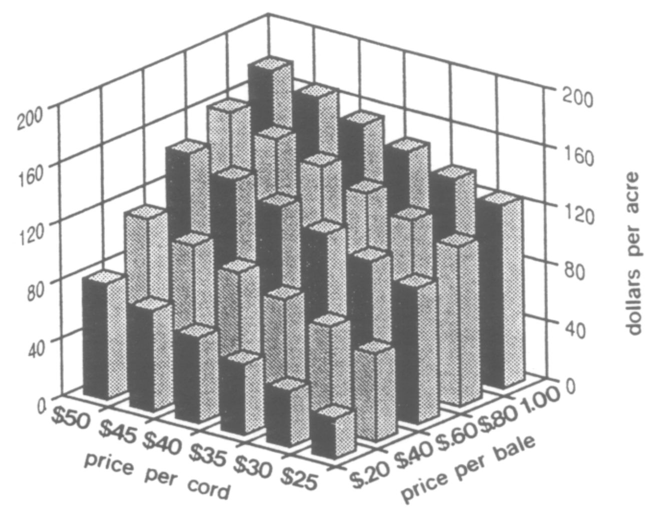

Figure 6: Sensitivity of fertilization investments to changes in stumpage and pinestraw prices. Analyses are for 5-year-volume response of 2.5 cords/acre, 175 additional bales of pinestraw, and 4% discount rate as in Table 3.

RETURN ON INVESTMENT - HERBICIDE APPLICATION

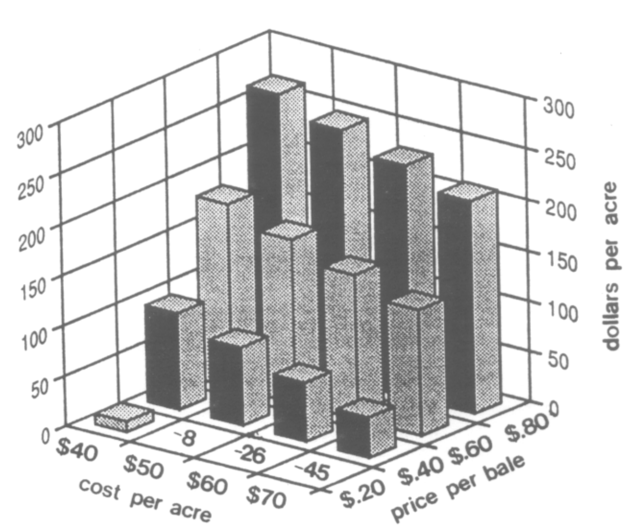

Figure 7: Sensitivity of herbicide application investments to changes in pinestraw prices. Based on an assumed yield increase of 55 bales/acre/year and a 4% discount rate as in Table 4.2

Table 2. Suggested guidelines for pinestraw harvesting and fertilization in the South.

Site Type	Stand Type	Stand Condition	Raking Frequency	Recommended Fertilization Regime	Monitoring
Flatwoods with fine-textured subsoils	Young Plantations	Suitable on sites with < 20% palmetto-brush ground cover	Annual beginning @ age 8	200 N, 50P, 80K, @ age 6; 200N, @ ages 11, 16	Foliar macro & micro-nutrients @ ages 11 and 16;
	Established Stands	Suitable on sites with < 50% palmetto-broad leaved ground cover	Twice during rotation following mid-rotation fertilization	150-200N, 50P @ ages 8-12	Macro & micro-nutrients prior to mid-rotation fertilization
Flatwoods without fine-textured horizons	Young Plantations	Suitable on sites with < 20% palmetto - broad leaved cover	Annual beginning @ age 8	200N, 50P, 80K @ age 6; 200N, @ ages 11,16	Macro & micro-nutrients sample @ ages 11 and 16;
	Established Stands	Suitable on sites with < 50% palmetto-broad leaved ground cover	Twice during rotation following mid-rotation fertilization	150-200N, 50P @ ages 8-12	Macro & micro-nutrients prior to mid-rotation fertilization
Upper and Middle Coastal Plain Uplands with loamy to sandy surfaces 20-40" deep	Young Plantations	Suitable on sites with slopes < 8%; moderately and well-drained	Annual beginning @ age 8	Old fields: 200N, 50P, @ age 6 200N @ ages 11,16	Macronutrients only - sample at ages 11 and 16;
				Cutover: 200N, 50P, 50K @ age 6 200N, @ ages 11, 16	Macronutrients only - sample @ ages 11 and 16
	Established Stands	Suitable with slopes < 12%; moderately well and well-drained	2-3 times during rotation following mid-rotation fertilization	200N, 50P, 50K @ ages 8-12	Macronutrients only - prior to mid-rotation fertilization
Middle & Upper Coastal Uplands with fine loamy to clay-textured horizons < 20" from the surface	Young Plantations	Suitable on slope < 5% in erosion class 1 (uneroded)	Annual beginning @ age 8	200N, 50P, @ age 6 200N, @ ages 11, 16	Macronutrients only - sample @ ages 11 and 16
	Established Stands	Suitable on slopes < 8% in erosion classes 1 and 2	2-3 times during rotation following mid-rotation fertilization	200N, 50P, 50K @ ages 8-12	Macronutrients only - sample prior to mid-rotation fertilization
Sandhill sites characterized by soils with sandy surfaces > 40" deep or without fine-textured subsoil	Young Plantations	----------	----------Not Recommended----------	----------	----------
	Established Stands	Suitable on slopes < 12%	Twice during rotation[1]/	None recommended	Growth plots

[1]/Decreased productive potential is possible for even a single raking on these sites. Such a decrease in tree growth must be balanced against income from straw production.

Table 3. Cash flows for a hypothetical acre in a slash pine plantation fertilized for pinestraw production at age 17. Benefits are for incremental gains associated with the treatment.

Plantation Age	17	18	19	20	21	22
COSTS:			$/acre			
Fertilizer Application	(54.00)	0	0	0	0	0
Foliage collection & Analysis	(2.00)	0	0	0	0	0
BENEFITS:						
Increased Pinestraw Production 1/	0	17.50	23.33	20.42	0	0
Increased Pulpwood Yield 2/	0	0	0	0	0	87.50
NET RETURNS:						
Discounted @ 4%	(56.00)	16.82	21.57	18.15	0	71.95
Present Value			128.49 - 56.00 = 72.49			

1/ Calculated assuming an increase of 900,1200 and 1050 lbs/acre litterfall during the first 3 years following fertilization; 75% recovery; mean bale weight of 18 lbs and a price-per-bale of $0.35.

2/ Assumes 5-year volume response to fertilization of 2.5 cords/acre at $35/cord.

Table 4. Cash flows for a hypothetical acre in a slash pine plantation following herbicide application at ages 12 and 18. Benefits are for incremental gains associated with the treatment.

Plantation Age	14	15	16	17	18	19	20	21	22
COSTS:					$/acre				
Herbicide Application	(50.00)	0	0	(50.00)	0	0	0	0	
BENEFITS:									
Increased Pinestraw 1/ Recovery	19.25	19.25	19.25	19.25	19.25	19.25	19.25	19.25	19.25
NET RETURN:									
Discounted @ 4%	(30.75)	18.51	17.79	17.11	(26.28)	15.82	15.21	14.63	14.07
Present Value					$113.14 - $57.03 = $56.11				

1/ Assumes 55 bale/acre/year increase in straw recovery and market value of $0.35/bale.

Additional Considerations

As already discussed, not all sites are suited for pinestraw management programs. Pinestraw should not be harvested from sites with above average erosion potential, or which are susceptible to surface soil compaction. Sites characterized by deep sandy soils are sensitive to organic matter removal and productivity of these soils may be damaged by pinestraw harvesting. On such sites, fertilization with inorganic nutrients is unlikely to compensate for nutrient and organic matter removal in pinestraw harvests. Fertilization can also stimulate growth of undesirable understory plants, particularly raspberry and honeysuckle vines. Since widespread occurrence of these vines can affect the suitability of a site for raking, intensive pinestraw management should not include sites with vines established in the understory.

The effective use of fertilizer requires that practitioners appreciate the many effects that nutrient additions can have on a forest ecosystem. For example, many reports have shown that the incidence and severity of certain tree diseases such as fusiform rust and pitch canker increase with increasing fertility and more intensive forest management (Dinus and Schmidtling 1971, Hollis et al. 1975). Although the causal mechanisms are not fully understood, managers are encouraged to monitor health in stands that receive repeated applications of fertilizer as part of a pinestraw management program.

Finally, the grass-free and shrub-free understory conditions that are ideal for pinestraw harvesting operations provide little understory vegetation diversity and few wildlife benefits. The costs associated with this more limited habitat are not considered in the example financial analyses provided in tables 3 and 4. Benefits associated with reduced pine stand regeneration costs resulting from understory reduction are also excluded from the analyses in these tables. Thus, these analyses must be considered preliminary. Additional evaluation will be required as information from recently installed studies of pinestraw management[3] becomes available.

[3]Research on pinestraw management is currently underway in Georgia, Alabama, Florida and North Carolina.

Summary

1. Pinestraw can be commercially harvested from longleaf, slash and loblolly pine beginning at age 8. Straw is most easily harvested from stands free from understory competition but can be raked from stands containing a grass understory.

2. Site suitability for pinestraw production is influenced by erosion potential, water and nutrient supply characteristics of the site. Old-field sites with low slope in the middle and upper Coastal Plain are most suitable for pinestraw production. Flatwoods sites are intermediate in suitability and sandy upland sites are least suitable for pinestraw management programs.

3. Supplemental fertilization will be required for sites from which pinestraw is harvested.

4. Financial analyses of pinestraw management programs require reliable information on straw production and forest growth; the costs of silvicultural operations, and the value of products produced. Initial analyses indicate that investment in pinestraw production can be profitable.

5. Monitoring of the effects of pinestraw management on site and stand conditions is recommended as an integral component of a pinestraw management program. The flexibility to adjust to changing stand conditions should be maintained.

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