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ENERGY WOOD HARVESTING

A STUDY OF PROMISES AND PITFALLS

BY

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INTRODUCTION

The oil embargo of 1973-74 and continuing instabilities in the Middle East have focused attention on alternate energy sources. The use of woody biomass as an alternate energy source presents potential opportunities and problems for the owners and managers of forestland. Among the potential opportunities is the promise of markets for previously unmerchantable material and a mechanism for increasing production of the quality timber required for many traditional wood products (2). Among the potential problems are nutrient removal, leaching, and erosion that could reduce the productive capacity of the forestland--an aspect of more intensive harvesting that is of international concern (5). This paper describes research in progress to define more precisely the potential benefits and impacts associated with intensive harvesting of wood for energy.

RATIONALE AND OBJECTIVES

Investigations described here are confined to the mixtures of low-quality hardwood and pine that typify much of the Upper Piedmont (figure 1). Two intensities of whole-tree harvesting were chosen. The most drastic treatment was to remove all woody biomass down to and including stems of approximately 1-inch in diameter at breast height. The other harvest intensity was to remove all stems with a breast height diameter of 4 inches and larger. Several operational and biological factors were considered in arriving at the two intensities in combination with the two seasons of harvest.

From an operational standpoint, we began with the premise that no management whatever will take place in the type of stand studied unless the material can be economically removed for fuel. Most of the material is not suitable for any other wood product, and expected return on investment is too low to justify the cost of clearing such sites and establishing more valuable species. The 4-inch diameter was used because it is the approximate lower limit for commercial harvest of fuelwood: no larger diameter limit is appropriate because no alternate product is possible. The 1-inch limit cut was included because, even though the smaller classes will not pay their way, removal of the small material may be justified by long-term benefits to the new stand. More than a generation of experience has demonstrated that on most nonindustrial private forest acreage no management activities will take place after logging. Even after the most intensive clearcuts to date, cull stems and small residuals of such poor quality that management often is not feasible dominate the new stand (4). If a fuelwood harvest will pay for removal of all the woody biomass, the species composition and structure of the new stand may support future harvests for a combination of fuel and other wood products. Thus, an intensive whole-tree harvest--the only likely treatment on much acreage--may, by itself, initiate a cycle of commercial production.

Figure 1. Low-quality hardwood-pine mixture in the Upper Piedmont

A number of factors must be considered in choosing an intensity and season of harvest. Total nutrient removal by harvesting, erosion, and leaching is obviously related to harvest intensity. In addition, since hardwood foliage contains a higher nutrient concentration than other tree components, harvesting during the summer, when the trees are in full foliage, may remove more nutrients than a winter harvest. This is not the only consideration, however. For some species, evidence exists that stump sprouting is more prolific following winter harvests than after summer harvests (1). Summer harvesting, therefore, may result in less sprouting and a higher ratio of seedling to sprout reproduction. Most seedlings will likely be conifers and light-seeded, intolerant hardwoods with a higher commercial value than the heavy seeded hardwoods that currently dominate (3). In other words, intensive summer harvesting will theoretically have the greatest positive impact on commercial species composition and stand structure. The ultimate objectives of the research are to estimate the positive and negative influences and quantify the tradeoffs between them.

PROCEDURES

The research is being conducted on the Dawson Forest, Dawson County, in the Upper Piedmont of Georgia, which is managed by the Georgia Forestry Commission. Commission personnel conducted the harvesting operations during the winter of 1979-80 and the summer of 1980. A typical whole-tree system, consisting of a feller-buncher, grapple skidders, and an 18-inch chipper, was employed (figure 2).

The sites had at one time been farmed, then abandoned and allowed to revert to forest. The resulting timber stands have been high-graded until no merchantable timber remains or the merchantable volume is too low for traditional logging. Basal area averages about 100 square feet per acre, of which about 65 percent is hard hardwood, 10 percent soft hardwood, and 25 percent pine. Hard hardwood diameters range from 1 to 20 inches, soft hardwood from 1 to 16 inches, and pine from 1 to 14 inches. The soil type is Fannin fine sandy loam with inclusions of Tallapoosa fine sandy loam.

Each combination of season and harvest intensity, as well as a control, is replicated three times on 1-acre logging plots with detailed measurements and sampling confined to the interior ½-acre.

Site impact is being characterized via estimates of logging disturbance, total site nutrient pools, and nutrient removals.

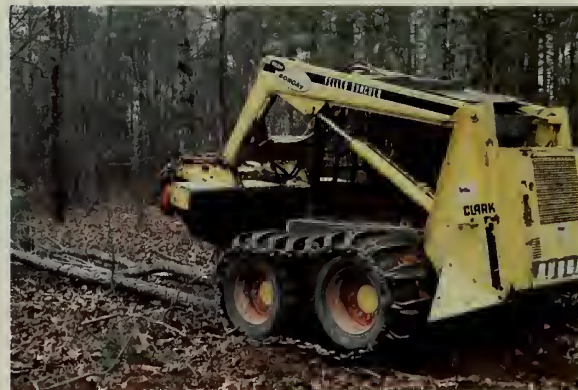

Figure 2. (a)

Figure 2. (b)

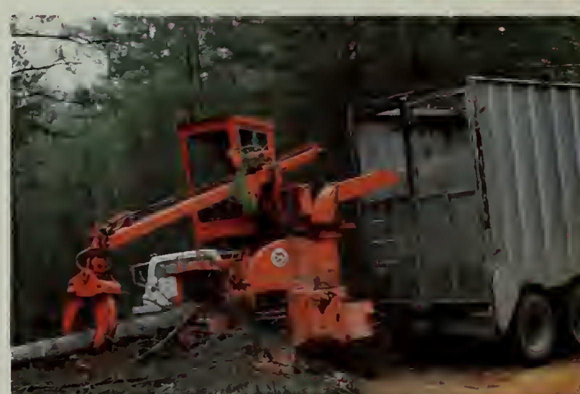

Figure 2. (c)

Figure 2. Whole-tree harvesting system consisting of (a) feller-buncher, (b) grapple-skidder, and (c) chipper.

Logging disturbance is estimated on the basis of a 180-point systematic grid within each plot. Each point is classed as (1) undisturbed, (2) mineral soil exposed but not dislocated, or (3) soil dislocated.

Amounts of nutrients in aboveground biomass, in the forest floor, and in the soil are estimated. Samples of the forest floor and soil are collected on a systematic grid. Composite samples of aboveground biomass were obtained by chipping all harvested material and taking periodic grab samples as the chips were blown into a van, which was then weighed. All nutrient samples are being analyzed for nitrogen, phosphorous, potassium, calcium, magnesium, aluminum, iron, manganese, and zinc.

Vegetation

Influences on forest vegetation will be gauged by estimating (1) the degree of competition to seedlings by residual stems and sprouts, (2) pine seedling establishment, (3) species composition and structure of the succeeding stands, and (4) biomass regrowth.

Differences in shade competition resulting from the two harvest intensities are being estimated by measuring light intensities in the photosynthetically active range of the solar spectrum. Instantaneous readings are taken on cloudless days within 1 hour of solar noon at 40 groundline sample points along the diagonal of each plot.

Initial pine seedling establishment will be estimated from milacre inventories along the same systematic grids utilized to estimate soil disturbance.

Species composition, stand structure, and biomass regrowth will require at least 5 years to estimate. The first two variables will be obtained from complete inventories of the ½-acre measurement plots and biomass regrowth from area subsamples within those plots.

PRELIMINARY RESULTS AND DISCUSSION

Although definitive conclusions cannot be made yet, some preliminary results are available. Total biomass removed under the most intensive harvest ranged from 67 to 83 green tons per acre. Moisture content of biomass ranged from 61 to 72 percent of ovendry weight. It is estimated that harvest to the 4-inch limit will yield approximately 15 percent less tonnage than harvest to the 1-inch limit. As the diameter limit is decreased, however, the number of stems handled increases substantially. Of the approximately 980 stems per acre, almost 60 percent are from 0.5 to 2.4 inches in diameter, but these stems account for only about 8 percent of the total basal area per acre (Table 1). These data point up a need for reliable information on whole-tree harvesting costs for small stems.

Table 1. Relative distribution of number of stems and basal area by diameter. (1980 stems per acre, 103 square feet of basal area per acre).

Diameter range	Trait	
	Stems/A	Basal Area/A
inches	— — — — — percent — — — — —	
0.5 - 2.4	58.6	8.4
2.5 - 4.4	20.9	17.4
4.5 - 6.4	9.9	18.3
6.5 - 8.4	5.1	16.7
8.5 - 10.4	3.5	18.6
10.5 - 12.4	1.2	9.1
12.5 - 14.4	0.5	5.5
14.5 - 16.4	0.2	3.6
16.5+	0.2	2.3

Table 2. Area of exposed mineral soil by intensity and season of whole-tree harvesting.

Season	Harvest Limit	
	1 inch	4 inches
	— — — — — Percent — — — — —	
Winter	71	35
Summer	61	30

Light measurements to date indicate that the two intensities of harvest led to substantial differences in competition from residual stands. The 4-inch limit plots receive less than 70 percent as much photosynthetically active isolation as the 1-inch limit plots during the summer (figure 3). This result documents the general consensus among foresters in the region that commercially clearcut areas need further treatment if intolerant species are desired as a major component of subsequent stands. The least intensive harvest in this study removed more material than would be removed in the typical commercial clearcut.

The area of soil disturbed by logging was logical and consistent both by season and intensity of harvest (Table 2). During both seasons the 4-inch-limit harvest disturbed half as much area as the 1-inch. Also, both intensities disturbed only 86 percent as much area during the summer as during the winter when the soil was moist. No conclusion can be drawn at present about the relative influences of soil disturbance under the two harvest intensities. Our ultimate goal is to define tradeoffs in terms of commercially utilizable production. The earliest indicator will be initial pine seedling establishment. Pines are singled out for special attention here because of their relative worth compared to hardwoods on the upland sites studied. General observations indicate that pine seedlings are becoming established in the most intensively harvested areas in a much greater proportion than their representation in the initial stands (figure 4).

Figure 3. (a)

Figure 3. (b)

Figure 3. Residual stands following harvests down to (a) 4-inch and (b) 1-inch diameter limits.

Preliminary estimates of macronutrient removal are presented in Table 3. Average nutrient removal per acre for all harvested plots was 300 pounds of nitrogen, 15.6 pounds of phosphorous, 110 pounds of potassium, and 500 pounds of calcium. Preliminary statistical analyses indicate that removal of biomass and of nitrogen, phosphorous, and calcium were significantly influenced by season of harvest, but not by intensity of harvest. Even conclusions about short-term nutrient removal cannot be made until forest floor and soil analyses are completed, and it will take many years to determine the more important question of impact on long-term site productivity.

SUMMARY

This paper reports preliminary results from a whole-tree harvesting study in mixed stands of hardwood and pine in the Upper Piedmont. Treatment variables are season of harvest in combination with diameter-limit cutting down to 1 inch and 4 inches. Biomass yields ranged from 67 to 83 green tons per acre, and biomass moisture content ranged from 61 to 72 percent. Photosynthetically active solar insolation is only 70 percent as intense under the residual 4-inch-limit stands as under the 1-inch-limit stands. Soil disturbance under the 4-inch-limit was half that under the more intensive harvest and only 86 percent as much area was disturbed in the summer as during the winter. Nutrient removal, averaged for all treatments, was approximately 300, 15.6, 110, and 500 pounds per acre of nitrogen, phosphorous, potassium, and calcium, respectively. The study is continuing to determine impact on site productivity and forest management options.

Figure 4. Pine seedlings established within 6 months of the most intensive harvest.

Table 3. Preliminary estimates of the mass of nutrients removed in whole-tree chips by intensity and season of harvest.

Diameter limit and season of harvest	Nutrient N	P	K	Ca
	——————pounds/acre ——————			
1 inch Summer	340	16.8	113	546
1 inch Winter	282	14.9	108	493
4 inches Summer	339	17.2	117	569
4 inches Winter	238	13.5	101	448
MEAN	300	15.6	110	500

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