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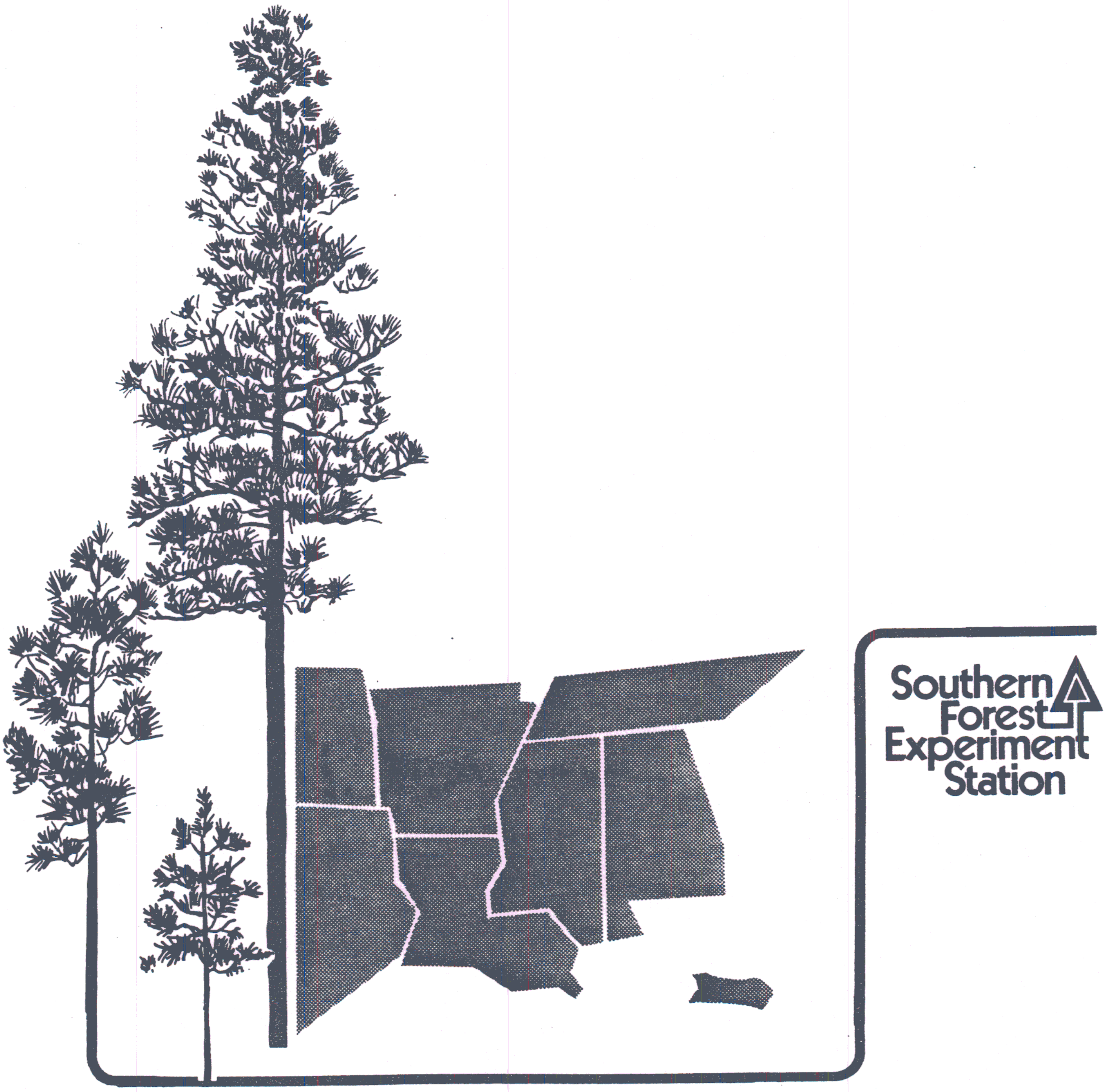

ECONOMIC ANALYSIS OF POTENTIAL FUELWOOD SOURCES[1]

W. F. Watson, J. R. Ragan, T. J. Straka, and B. J. Stokes[2]

ABSTRACT.--Fuelwood can be produced from mill residues, logging residues, or energy plantations. This paper will compare the last two sources on the basis of potential for production and expected costs at the various levels of production. Prospects for improving the production of fuelwood from each source will also be examined.

Wood for energy is available from three sources: manufacturing residues, logging residues, and energy plantations. Manufacturing residues are by far the most important of these sources. Pulp and paper mills are increasingly becoming more energy self-sufficient by making use of cooking liquors and bark to fire their boilers. In many part of the South, low cost sawmill residues are available to provide the remainder of the pulp and paper mill's energy needs. However, more sawmills are using their own bark and sawdust as boiler fuel to power their kiln. Add to this increased cogeneration activity, and we begin to see a scarcity in manufacturing wood residues for a fuel source.

The scarcity of manufacturing residues has caused corporate managers to look to the other two sources of wood for fuel stock. Conventional logging operations harvest as little as 50 percent of the aboveground biomass, leaving a large supply of unutilized energywood either standing or on the ground. Studies of short rotation grown soft hardwoods have shown that yields of 5 green tons of biomass per year in the first rotation are easily obtained, with the potential for even greater yields from the second rotations originating from stump sprouts.[3]

Logging residues and energywood plantations afford potential for producing great volumes of energy material. The question of concern for either source is "Can the energywood be economically produced?"

UTILIZATION OF LOGGING RESIDUES

Logging residues are available at a free stumpage rate since this material must be destroyed or removed to regenerate the next stand. In fact, since the intensity of the site preparation treatment required depends upon the amount of unutilized material to be removed, residue removal can generate a site preparation credit.

Early methods of recovering this unutilized material centered on residue recovery in a post-harvest operation. Notable endeavors in this field were Georgia-Pacific's Jaws II machine (Logger and Lumberman 1980) and the Koch-Nicholsen machine (Sirois 1981). Both machines were prototypes which involved considerable equipment investment for the felling/chipping recovery process and required specialized forwarders for moving the processed energywood to roadside. Neither machine met with acceptance due to economic considerations.

Another approach for recovering this residue began to evolve in the forest industry. This approach involved recovering the potential residue in the preharvesting or harvesting operation. These methods were tested with Scott Paper Company in Alabama (Watson, Stokes, and Savelle 1986; Miller 1986) and were found to be reasonably economical.

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[1]A paper presented at the 1986 Society of American Foresters National Convention held at Birmingham, Alabama, on October 5-8, 1986.

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[3]Personal communication with William Wharton, Jr., Manager of Technical Services, Scott Paper Company, Mobile, Alabama.

The preharvest of energywood will be referred to as the first pass of a two-pass system. In the two-pass system, conventional high speed feller-bunchers felled all unmerchantable stems in a first pass through the stand. The feller-bunchers made large bundles of this energywood material. The bundles of energywood were then skidded to a road side using grapple skidders, chipped, and transported to the mill to be used as fuel. A great advantage of this operation was that the stems could be felled several weeks before skidding to take advantage of the transpirational drying, resulting in a reduction of moisture content in the fuel. The second pass in this operation consisted of removing the merchantable stems with a conventional operation.

The two-pass method of energywood harvest was found to be highly sensitive to the volume of material available on the site to be processed (Miller 1986). Low volumes of energy material required the feller-buncher to spend much of its cycle in the travel-to-dump phase and drove felling costs up to unacceptable levels. When energywood volumes reached 15 tons per acre, this method was found to put energywood into the chip van at a cost of $12.50 per green ton. At levels of biomass above 30 tons per acre, the stump-to-truck cost became asymptotic at $9.00 per green ton. With a delivered value of the material at $15.00 per green ton, this two-pass method would be an economically feasible method of producing energywood up to 60 miles from the mill.

The one-pass method involves felling the energywood and the merchantable material in a single pass through the stand. Conventional feller-bunchers were used to fell and segregate the energywood and merchantable material into separate piles at the stump. Grapple skidders were used to move the energywood stems to an in-woods chipper. Merchantable stems were moved by the grapple skidder to a topping area alongside the chipper where chainsaw operators topped the stems at a point near the base of the crown. The tops of the merchantable trees were then fed into the chipper to also be used for fuel. The boles of the merchantable stems were

Table 1.--Short rotation biomass plantation activities and associated costs (for six-month periods).

Item	Period 0	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9
Land Cost	$ 65.00		$65.00		$65.00		$65.00		$65.00	
Annual Mgmt. Costs		$12.00		$12.00		$12.00		$12.00		$12.00
Annual Tax Costs		1.75		1.75		1.75		1.75		1.75
Site Prep	15.00									
Planting Stock	108.90									
Planting Costs	87.12									
Maintenance Discing		15.00		15.00						
Herbicide Cost Applied		22.36		22.36						
Spot Herb Treatment						10.00		10.00		
Fire Prevention	1.50		1.50		1.50		1.50		1.50	
Harvest and Transport										10.00/ Green Ton
Total	$277.52	$51.11	$66.50	$51.11	$66.50	$23.75	$66.50	$23.75	$66.50	$13.75*

*Excludes harvest and transportation costs

Table 2.--Cost per mmBTU's and green tons and the comparative break-even price for fuel oil and coal.

		Sycamore				Fuel Oil		Bituminous Coal	
		Cost/mmBTU's*		Cost/Ton		Cost/Barrel		Cost/Ton	
Interest Rate	Green Tons Per Acre	1986$	1991$	1986$	1991$	1986$	1991$	1986$	1991$
	20	3.33	4.49	39.55	53.22	21.26	28.66	93.24	125.72
	25	2.79	3.76	33.12	44.58	17.81	24.00	78.12	105.28
6%	30	2.43	3.27	28.83	38.82	15.51	20.88	68.04	91.56
	35	2.17	2.93	25.78	34.70	13.85	18.71	60.76	82.04
	40	1.98	2.67	23.49	31.62	12.64	17.05	55.44	74.76
	20	3.20	4.74	37.94	56.25	20.43	30.26	89.60	132.72
	25	2.67	3.96	31.70	47.00	17.05	25.28	74.76	110.88
8%	30	2.32	3.44	27.55	40.83	14.81	21.96	64.96	96.32
	35	2.07	3.07	24.58	36.43	13.21	19.60	57.96	85.96
	40	1.88	2.79	22.35	33.13	12.00	17.81	52.64	78.12
	20	3.08	5.02	36.48	59.50	19.66	32.05	86.24	140.56
	25	2.56	4.18	30.39	49.61	16.34	26.69	71.68	117.04
10%	30	2.22	3.63	26.33	43.00	14.17	23.17	62.16	101.64
	35	1.98	3.23	23.52	38.29	12.64	20.62	55.44	90.44
	40	1.79	2.93	21.26	34.75	11.43	18.71	50.12	82.04

*Cost per net mmBTU's

then skidded on to a loader and were loaded out in a tree length form. The cost of harvesting the energywood (stump to truck) using the one-pass method was found to be less than $10.00 per green ton in all cases and as low as $7.25 per green ton in some instances. When a value of $15.00 per green ton is assumed for delivered energywood, an ample margin for transportation costs is available up to 75 miles from the mill.

The one-pass method or producing energywood in this "hot" fashion does not allow for the transpirational drying that can be accomplished in the two-pass method. Several firms have implemented this method by only felling in a single pass. The merchantable material is removed immediately with the energywood being removed at a later date. This still reduces the felling costs but level of recovery is reduced since the merchantable tops are not utilized.

ENERGY PLANTATIONS

The great concerns in energy plantations are that the stumpage is not free and the lack of equipment to handle these special situations. Either of these concerns could spell the economic ruin of implementing energy plantations.

The best scenario for an energy plantation is to grow a fast growing species, such as sycamore, on a short rotation (5 years), harvest the first crop, and allow a second crop to regenerate by coppice. Trees should be planted in rows wide enough to allow for cultivation, but need to be only 4 to 5 feet apart in the row. To realize the growth potential in short rotation stands, very fertile agricultural land is required. This type land will lease for $65.00 per acre. Before planting, a preemergence herbicide application is required and intensive cultivation and herbicide treatments are required in the first two years of growth. Spot herbicide treatments are required in the third and fourth years of growth. The costs of the practices[4] required are summarized in Table 1. (Each period in the table represents a 6 month interval.) Note that a $10.00 per green ton harvesting and transportation cost is assumed in this scenario and will be discussed later. Table 2 demonstrates the sensitivity of this total delivered cost including stumpage to levels of yield and interest rates. In most cased the costs are higher than the cost of logging residue but are favorable when compared to breakeven costs of oil or coal (Table 2).

[4]Costs are based on information obtained from Walter Anderson, USDA, New Orleans, La.; Harvey Kennedy, USDA, Stoneville, Miss.; and Bryce Schlaegel, USDA, Stoneville, Miss.

To realize the best logging costs for energy plantations, machines are needed which can take advantage of having similar sized small trees in a straight row. The National Research Council of Canada has supported the development of such a machine, the Hyd-Mech. The Hyd-Mech is a felling head carried on an articulated rubber-tired carrier. The machine has been tested in a 3 year old sycamore plantation owned by Scott Paper Company and located in South Alabama.[5] This study found that the machine could fell 850 stems per hour or 17 green tons per hour. If the productivity in stems per hour could be maintained, the tonnage per hour could be greatly increased when the trees are allowed to grow to age 5. Even in these small stems, the felling cost was $3.25 per green ton.

The Hyd-Mech also produces large bundles; thus, grapple skidders are appropriate for moving the felled stems to a chipper for processing. In the study of this system, total cost into the chip van was $7.65. The chipper used in this study was found to be too large for the stems being processed; thus, the costs could be further reduced in an optimal system. This harvesting system, as was tested, could produce chips to a boiler 25 miles away at a cost of $10.00 per green ton. With larger stems and optimal machines, the chips could be produced for $10.00 per ton at even greater distances from the boiler.

CONCLUSIONS

Utilization of understory biomass as a fuel is economically feasible under the following conditions:

1. The material has a high value at the woodburning facility,
2. A credit is applied to the energywood for site preparation savings,
3. Larger volumes of the energywood are available on the acre, and
4. The energywood is relatively near a using facility

Energy plantations are feasible when:

1. They can be located near the using facility, and
2. The price of alternative fuel sources are high.

A viable situation could involve the use of both methods for the production of a fuel stock. The understory material could be utilized in the zones near the mill where it was economical, with energy plantations available to take up slack in the supply when alternative energy supplies are unavailable or when their costs are high.

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[5]Information was obtained from a paper by B. J. Stokes, D. J. Fredrick, and D. T. Curtin soon to appear in Biomass.