

ABSTRACT --Current legislative initiatives at the local, state, and Federal level are aimed at achieving higher levels of recovery of waste material currently deposited in landfill sites in the United States. In view of these initiatives, the USDA Forest Service evaluated the impact of higher levels of wastepaper use on regional pulpwood markets. An economic model, developed at the Forest Products Laboratory, was used to make regional projections of paper and paperboard production, pulpwood and recycled fiber consumption, and pulpwood prices under two scenarios--Base Case and High Recycled Fiber. Projections for the High Recycled Fiber scenario show U.S. paper and paperboard production increasing above the Base Case scenario level and shifting toward manufacturing processes that use a higher percentage of recycled fiber. As a result, projected pulpwood consumption and (delivered) pulpwood prices in most regions are lower than those projected in the Base Case scenario.

INTRODUCTION

In recent years, concern over solid waste disposal in the United States has grown. As the volume of solid wastes generated from all sources increases, many existing landfills are reaching maximum capacity and are being closed. At the same time, new landfill sites are increasingly difficult to find. This has focused national attention on alternative solutions to landfilling, primarily source reduction and recycling.

A national goal set by the U.S. Environmental Protection Agency calls for a 25 percent reduction in solid wastes by 1992 (DeKing and Garcia 1989). Reaching this goal will require a sharp increase in waste recycling from the current national rate of 12 percent of total waste generated. At 40 percent of the total solid waste stream (Iannazzi 1989), paper and paperboard products comprise the largest category of wastes in the United States and have thus been targets for numerous legislative actions aimed at recycling. The prime target has been old newspapers. Legislation currently passed or pending in many states and municipalities is aimed at increasing recycling of old newspapers (Iannazzi 1989; Pulp & Paper 1989). In October of 1989, a bill was introduced in the U.S. Congress that would require an increasing percentage of newsprint sold in the United States be made from old newspapers (Wetzstein 1989).

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In terms of weight of solid waste, wastepaper is already the largest recycled category of waste materials in the United States. The tonnage of recycled wastepaper greatly exceeds the tonnage of other post consumer materials being recycled. Use of recycled fiber (generated from wastepaper) in paper and paperboard products has been increasing for many years. The utilization rate is currently at 25 percent of total tons of paper and paperboard produced (American Paper Institute

1988b). Although this rate is far lower than the rate in Japan (51 percent) and West Germany (44 percent), and lower than the world average (31 percent), it is much higher than the rate in Canada (10 percent) and Sweden (11 percent) (Olkinuora 1989). The use of recycled fiber in the United States is expected to be much higher in the future, given appropriate technological developments.

Use of recycled fiber in paper and board products affects the amount of new wood pulp used and, therefore, has an impact on pulpwood markets. As use of recycled fiber increases, the amount of new wood pulp needed decreases and pulpwood requirements decrease as well.

The USDA Forest Service conducted an analysis of the impacts of future high levels of wastepaper use on regional pulpwood markets in the United States. Results were incorporated in the 1989 Renewable Resources Planning Act (RPA) assessment of the Nation's timber resource. This assessment looks at current and future trends in the supply and demand for timber. It includes long-term projections for various wood product markets, including pulpwood for paper and board products. These projections comprise the Base Case scenario, which assumes a gradual increase in wastepaper recycling. Projections resulting from the analysis of future impacts of high wastepaper use comprise the High Recycled Fiber scenario--an alternative future scenario to the Base Case scenario. The High Recycled Fiber scenario assumes a much faster increase in wastepaper recycling over the next several decades.

The purpose of this paper is to describe the methods and to discuss the results of this Forest Service analysis of future high levels of wastepaper use in the U.S. pulp and paper industry--the High Recycled Fiber scenario.

METHODS

Pulpwood Model

Projections for the High Recycled Fiber scenario were developed using the Forest Service Pulpwood Model. (For a description of the Pulpwood Model see "Modeling Future Technological Change and Fiber Consumption in the Pulp and Paper Industry," by James L. Howard and others, in this Proceedings.) This is an economic model of the North American pulp and paper industry that projects regional levels of production, fiber requirements, and pulpwood consumption over a 50-year period. It projects market equilibrium quantities and prices for various product and raw material commodities. Most importantly, it incorporates assumptions about future technological developments and models their adoption over time (Durbak et al. 1989).

The Pulpwood Model was used to develop the Base Case scenario for the U.S. pulp and paper industry. This scenario was incorporated in the 1989 Forest Service RPA analysis and assessment of

the national timber resource. The Pulpwood model was also used to simulate alternative scenarios related to product demand, production technology and costs, raw material supply, and general economic conditions. This was done by changing assumptions, specified by region, about any of the specific variables in the database, such as

1. Fiber requirements
 - a. Wood pulp, by grade of pulp and process
 - b. Recycled fiber, by category and process
2. Pulpwood consumption
 - a. Wood pulp yield, by grade of pulp
 - b. Pulpwood use per ton of product
 - c. Hardwood and softwood mix
3. Nonfiber manufacturing costs
4. Projected growth in Gross National Product and population
5. Projected growth in supply of raw materials
6. Elasticities for demand and supply functions

Assumptions and Processes for High Recycled Fiber Scenario

In developing the High Recycled Fiber scenario, we made the following two general assumptions.

1. The availability of wastepaper for recycling will increase as current efforts to reduce landfill use and to increase waste recovery accelerate.
2. Technological developments will occur that will increase use of recycled fiber in most paper and board grades, including such grades as Printing & Writing papers and Linerboard, which have traditionally been produced using mostly virgin wood fiber. This will require major improvements in removing inks and other contaminants and in restoring strength of recycled fiber.

We incorporated the first assumption into the Pulpwood Model by increasing the upper bound in the wastepaper supply functions and by decreasing wastepaper prices. We incorporated the second assumption by increasing the percentage of recycled fiber and decreasing the percentage of wood pulp in the fiber mix for certain paper and board product grades and manufacturing processes. Reviewer comments and information provided by industry experts were helpful in estimating the increased levels of recycled fiber use for each paper and board grade and for the paper and board industry as a whole.

In the Pulpwood Model, we modeled Newsprint and the four paperboard grades (Unbleached Kraft, Solid Bleached, Semichemical, and Recycled) by identifying alternative current and future manufacturing processes. These processes are defined in terms of fiber requirements and nonfiber costs. In each year of the projection period and in each region, the model selects the

most cost-effective combination of processes to meet equilibrium quantities of production.

For Newsprint, we had identified four alternative manufacturing processes that were then modeled in the Base Case scenario. Two of these processes were defined as already using high percentages of recycled fiber--100 percent and 50 percent. Therefore, no changes were made in these processes for the High Recycled Fiber scenario. For Semichemical paperboard, we had identified three manufacturing processes for the Base Case scenario, including one process that used 40 percent recycled fiber. Again, no process changes were made for the High Recycled Fiber scenario. In the case of Unbleached Kraft and Solid Bleached paperboard, however, we increased the percentage of recycled fiber in the alternative future processes identified for the Base Case scenario. Table 1 shows the fiber requirement assumptions for these two paperboard grades, by manufacturing process.

Table 1. --Fiber inputs for Unbleached Kraft and Solid Bleached paperboard processes.

Process	Base Case scenario	High Recycled Fiber scenario
	Fiber inputs (percentage of total fiber)	
Unbleached Kraft Paperboard		
Process 1 (current)		
Unbleached Kraft pulp	93	93
Recycled fiber	7	7
Process 2 (current)		
Unbleached Kraft pulp	85	85
Recycled fiber	15	15
Process 3 (future) ^a		
Unbleached Kraft pulp	85	81
Recycled fiber	15	19
Process 4 (future)		
Unbleached Kraft pulp	50	42
Mechanical pulp	30	30
Recycled fiber	20	28
Solid Bleached Paperboard		
Process 1 (current)		
Bleached Kraft pulp	100	100
Process 2 (future)		
Bleached Kraft pulp	37	40
Mechanical pulp	63	30
Recycled fiber	--	30

^aGreater wood-using efficiency and lower manufacturing cost than Process 2.

For the remaining paper grades (Newsprint, Printing & Writing, Packaging & Industrial, and Tissue) and for Construction Paper & Board, we did not define alternative manufacturing processes. For these grades, we increased recycled fiber use relative to wood pulp, projecting increasing levels over time exogenously. For example, Table 2 shows estimated current (1986) and projected (2000, 2040) fiber requirements for Printing & Writing and Tissue papers.

RESULTS

Results for the Base Case and the High Recycled Fiber scenarios show U.S. production of paper and paperboard will more than double by the year 2040 (Table.3). Production is projected to reach a slightly higher level in the High Recycled Fiber scenario, especially in the North (Table 3). This is mostly due to higher U.S. Newsprint production in this scenario. By the year 2040, Newsprint production is projected to be 5 percent higher than in the Base Case. In addition, in the High Recycled Fiber scenario, most Newsprint production is projected to shift to the North, thus the increase in overall production in the North. In both scenarios, Newsprint production gradually shifts to a manufacturing process that uses 100 percent recycled fiber.

Less pulpwood use is projected in the High Recycled Fiber scenario, especially in the South and West, as the industry turns to greater use of recycled fiber for most paper and board products. Total pulpwood consumption for paper and board products is projected to reach 138.1 million cords in the year 2040. This is 12 percent lower than total pulpwood consumption in the Base Case scenario (Table 3).

In both scenarios, consumption of hardwood pulpwood is projected to increase much more than consumption of softwood pulpwood. This is due to a projected increase in the substitution of hardwood for softwood fiber, especially in chemical pulping processes. Consumption of hardwood pulpwood is projected to more than double by the year 2040. The consumption level reached in the High Recycled Fiber scenario, however, is 9 percent lower than that in the Base Case scenario. By the year 2040, consumption of softwood pulpwood is projected to increase 26 percent in the High Recycled Fiber scenario and 47 percent in the Base Case scenario. United States softwood consumption is projected to reach 79.5 million cords in the year 2040, which is 14 percent lower than softwood consumption in the Base Case scenario.

Consumption of recycled fiber is projected to increase markedly in both scenarios and in all regions (Table 3). Although the highest level of consumption is projected in the North, the greatest rate of increase in consumption is projected in the South.

United States consumption of recycled fiber is projected to almost quadruple in the High Recycled

Table 2.--Current and projected fiber inputs for Printing and Writing and Tissue papers.

Paper grade	Fiber inputs (percentage of total fiber)				
	Current estimate ^a 1986	Base Case scenario		High Recycled Fiber scenario	
		2000	2040	2000	2040
Printing and Writing					
Bleached sulfate pulp	76	73.5	70	73	68.0
Mechanical pulp	10	15.0	20	14	17.0
Recycled fiber	7	8.5	10	10	15.0
Other pulp and fiber	7	3.0	--	3	--
Tissue					
Bleached sulfate pulp	53	48	35	48	30
Mechanical pulp	1	5	15	2	10
Recycled fiber	34	45	50	45	60
Other pulp and fiber	12	2	--	5	--

^aAmerican Paper Institute 1986.

Fiber scenario, reaching 64.5 million tons in the year 2040. The recycled fiber utilization rate is projected to reach 38 percent in the year 2040, compared to 31 percent in the Base Case scenario. In the North, consumption is projected to almost quadruple, reaching 35.6 million tons in the year 2040. In the South, consumption is projected to increase almost fivefold, reaching 22.6 million tons in 2040.

In general, delivered pulpwood prices are expected to increase as pulpwood consumption increases. In the South, projected consumption of hardwood pulpwood, under both scenarios, increases faster than consumption of softwood pulpwood. As a result, the projected price of hardwood pulpwood increases faster as well, and the gap between softwood and hardwood pulpwood prices closes over time under both scenarios (Fig. 1). In the North, in contrast to the South, the gap is maintained under both scenarios, with projected pulpwood prices for softwood being higher than the prices for hardwood throughout the projection period.

In the High Recycled Fiber scenario, the projected price levels for (delivered) softwood and hardwood pulpwood are lower than in the Base Case. This occurs in all regions and reflects lower projected pulpwood consumption levels than the levels in the Base Case scenario. In the South, by the year 2040, the projected price of (delivered) softwood pulpwood is 28 percent lower than that in the Base Case: the projected price of (delivered) hardwood pulpwood is 29 percent lower.

CONCLUDING REMARKS

The Forest Service Pulpwood Model, developed at the Forest Products Laboratory, was used to make regional projections of paper and board production, pulpwood and recycled fiber consumption, and pulpwood prices. These projections were made for two future scenarios described in the Forest Service 1989 Renewable Resources Planning Act (RPA) assessment of the timber resource--the Base Case scenario and the High Recycled Fiber scenario.

The High Recycled Fiber scenario describes a possible alternative future in which higher levels of recycled fiber (wastepaper) are used in the U.S. paper and board industry. In this scenario, consumption of recycled fiber is projected to increase to a much higher level than in the Base Case scenario. Consumption of pulpwood, however, especially softwood pulpwood, is projected to increase to a lower level than in the Base Case scenario. This lowers projected prices of delivered pulpwood below the levels reached in the Base Case scenario.

Table 3.--Regional summary for the U.S. paper and board industry, with projections for the Base Case and the High Recycled Fiber scenarios.

	1986 Estimate ^a	2040 projections		
		Base Case scenario	High Recycled Fiber scenario	Difference (percent)
(million tons)				
Paper and board production	73.5	165.3	168.8	+2.1
North	24.9	64.1	69.4	+8.3
South	39.6	86.9	84.8	-2.4
West	9.0	14.3	14.7	+2.8
(million cords)				
Pulpwood consumption	91.1	157.4	138.1	-12.3
North	15.5	34.5	32.2	-6.7
South	59.0	100.8	86.7	-14.0
West	16.6	22.2	19.2	-13.5
(million cords)				
Softwood pulpwood consumption	63.0	92.9	79.5	-14.4
North	5.7	10.2	9.4	-7.8
South	41.6	62.3	52.2	-16.2
West	15.7	20.5	17.8	-13.2
(million cords)				
Hardwood pulpwood consumption	28.1	64.5	58.6	-9.1
North	9.8	24.3	22.8	-6.2
South	17.4	38.5	34.5	-10.4
West	0.9	1.7	1.3	-23.5
(million tons)				
Recycled fiber consumption	17.9	51.1	64.5	+26.2
North	9.3	25.3	35.6	+40.7
South	5.6	21.4	22.6	+5.6
West	3.0	4.3	6.3	+46.5

^aAmerican Paper Institute 1988a; American Paper Institute 1988b; U.S. Department of Commerce 1987; U.S. Department of Commerce 1988.

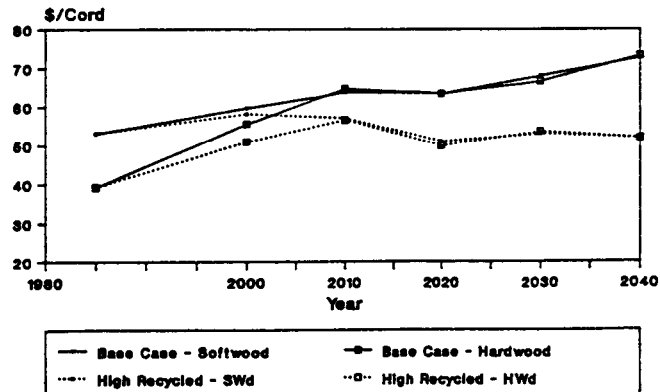


FIGURE 1.--Southern pulpwood prices (per cord delivered to mill) for alternate 1989 RPA scenarios.

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