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USES FOR FOREST RESIDUES¹

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Many uses exist for forest residues, and the Forest Products Laboratory receives numerous requests for information on the subject. This report is designed to furnish that information to people in the forest and wood-using industries, those who contemplate entering these industries, and others interested in conserving timber supplies. Consideration of the problems involved necessitates the discussion of some aspects of residue utilization that are quite obvious to the experienced operator but less apparent to others.

The existence of forest “residue” is proverbial. Much of this residue is uncontrollable, yet a large portion of it may be reduced. Because wood lacks the plastic flow qualities necessary for such major reshaping as is done with metals, the irregularly round shape and varying dimensions of the tree must be reduced to the required shape and size by removal of extraneous material. Parts of the trees, or entire trees, are rejected for a specific use because of size, shape, quality, or species. Such residue is often increased by poor operating practice or by mismanufacture, and some woods mismanufacture is the direct cause of residue in later stages of processing.

Forest residues wasted through nonuse can be reduced by preventive measures. The portion of the residue due to the nature of the raw material is unavoidable, of course, but improvements in operating practices and processing equipment

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can minimize further waste of usable material. Some residues unsuited for one product may be usable for another: thus, the harvesting of several products, such as ties and pulpwood in addition to logs, rather than sawlogs alone, is both a preventive and a salvage measure.

Possibilities for using forest residues are often severely limited by difficulties in handling and segregating them, or by their unadaptability to the consumer's needs or to his manufacturing processes. The consuming market may not be favorably located with respect to the source of the material or capable of absorbing all of it. The quantities available may be too limited for low-cost handling. Costs of fuel or construction materials needed to replace residues that are sold reduce the gains from sale of residue. Finally, wood residues may be of such form, condition, or species that serious technical difficulties will preclude their use for regular products with regular equipment.

Waste Prevention

Converting raw materials into principal products is more profitable than reworking residues into secondary products. This is because the market demand is usually greater for the principal products and they are in better form for efficient remanufacture. It is generally profitable to put extra effort into increasing the yields of the primary operation through training of labor, correction of equipment defects, and diversification of products. Logging crews can be trained to avoid breakage in falling trees and damage to the residual stand. Special attention in bucking has to be given to proper trimming allowance (so that boards will not lack an inch or two in length and have to be trimmed back--in the case of softwoods, to the next even 2 feet). Special attention must also be given to selection of log lengths that will eliminate crook, sweep, or grouped defects, and to placement of cuts to improve log grade and obtain additional products, such as ties or posts from the upper portions of the trees. Woods labor requires training to use wood from tops and low-value trees or species, instead of from straight young trees of desirable species, for road construction, cribbing, corduroy, drains, cordwood stakes, truck stakes, load-tightening levers, skidways, camp structures, or like purposes. Camp fuel should be derived from logging slash or unmarketable species.

Harvesting Equipment

Harvesting equipment has an important bearing on both prevention and salvage of residue. When the equipment is not adapted to the logging operation, or it is

too heavy for the material handled, it may not be able to profitably handle material that could be taken, at a profit, with lighter or better-adapted equipment. For example, in cutting small southern pine for pulpwood on the flatlands of the South, the wheel-mounted circular power saw makes ground-level stumps possible at a 0.2 cord per acre increase in yield. Light tractors in the Northwest can profitably recover slash and small trees on which the customary heavy equipment would lose money. Maintenance of equipment in first-class working condition, plus organization of work to minimize handling, makes it possible to recover more material profitably and to reduce waste accordingly.

Careful planning of the operation also makes it possible to remove a diversity of products, instead of some single product such as sawlogs. Multiple products not only utilize more of the tree but permit raising of grades by providing a greater range for selection. Poles, pulpwood, mine props, ties, posts, boxboard bolts, and cordwood are some of the products that may be removed in conjunction with veneer or sawlog cuttings.

Salvage of Residue

The woods operator has some opportunities to utilize residue in his own operation. Additional and more extensive opportunity is provided by the recovery of marketable secondary products. The sale of cordwood for fuel or pulpwood is an important outlet in some regions for material from tops, defective trees, noncommercial species, or thinnings. The production of charcoal, or chipped wood for various uses, may be practical. Short logs of good material may be recovered for sawed products, such as boards, squares, and the like, or for staves and numerous small products. Short billets of clear material may be cut from between branch whorls for such items as rotary-cut or sliced box veneer and paper cores. Slicer billets may be cut from hollow butts or from trimmings cut from logs to improve their grade. Other outlets for forest waste, especially from thinnings, include fencing of varied types, bean and hop poles, grape, tree, and oyster-bed stakes.

Apparently few dealers, other than retail fuel wood dealers, purchase woods residue for resale to a variety of users. Both for finished items made from waste (posts, ties, etc.) and rough billets for other products, individual customers usually must be sought. For some products produced in relatively small quantity by individual operators, where sales or processing are difficult and costly, a cooperative concentration yard or secondary processing plant serving a group of operators may be feasible.

Field of Utilization

Forest residue is potentially usable in varied forms: (1) in original or natural form (fuelwood, posts, litter for mulch); (2) in mechanically modified form (sawed or shaped, chipped, defibered, ground laminated); (3) in chemically modified form (chemical pulp, distillation, saccharification, extraction, hydrogenation, impregnation); and (4) in biochemically modified form (as in composted litter or in yeast and other fermentation products following saccharification).

Numerous properties and characteristics of wood are exploitable. In many products, it is the mechanical and physical properties that are employed. Uses for mechanical properties are commonplace. Wood residue constitutes a large source of fiber, heat energy, or chemicals. In some cases, appearance is the exploited characteristic, as in rustic furniture, in figured veneer products made from burls, stumps, crotches, etc., and in novelty or decorative products, such as holly leaves, mistletoe, pine boughs and cones, autumn leaves, tops of evergreens as Christmas trees, and birch bark. Also odor is exploited in fir pillows and pine-oil soaps.

Bulk and heat-insulating values of forest litter are utilized in bedding and mulching. Sound and thermal insulation, as well as strength properties of wood fiber, are employed in insulating boards, papers, and other pulp products. Use of wood for chemicals may involve extracting soluble constituents by leaching (tannin), vaporizing by steam (wood oils), or chemical treatment to liberate the desired constituents. Other chemicals not present as such may be derived by conversion of the wood by hydrogenation, hydrolysis, bacterial action, or destructive distillation. By combustion, useful heat energy is released for power and other uses. The resulting chemical products are discarded, except for some use of ashes as fertilizer.

Any program for utilization of forest waste depends in large measure on the vigor and business acumen of the individual management in (1) adapting the program to the circumstances peculiar to the materials and location (2) seizing temporary market opportunities, and (3) finding existing outlets or encouraging new stable outlets. Best control of marketing obviously results from internal adjustments of the operation in which the needs of the operator can be met by (1) using waste or lower-quality material to release better material for production, or (2) by producing secondary products from residue and marketing through regular sales channels. For example, a sawmill cutting its own timber and selling part of it as box material may work with the box manufacturer to develop a line of boxes to be made from veneer that is sliced from billets taken from tops,

branches, broken trees, or partially defective logs; or a forest owner may promote a cooperative concentration yard for accumulating salable quantities of props, veneer-grade logs, or other specialty items for which the quantity produced by the individual operator is too small for ready sale.

In setting up a program for waste utilization, the individual operator must make his own selection of outlets. This is because uses that are profitable in one region or under one set of circumstances may be money losers in another. Knowledge of operating conditions and of kinds and quantities of residue available, plus knowledge of nearby markets, are necessary to an intelligent choice of product to be made from the residue. To assist in such choice, tables 1-4 give, as fully as present information permits, a fairly complete list of uses for forest residue, with supplementary information on specifications, markets, consumption, and the like. In the tables, the term "unmerchantable" applies to species of wood.

Table 1--Physical uses of forest residue

Use	Material											Condition	Species	Sizes	Specifications, requirements	Purchasers, markets	Remarks	
	Unmerchantable	Trunks	Limbs	Branches	Stems	Stumps	Bark	Foliage	Green	Dry	Abundant							Peeled
Bedding, Packing, Mulching																		
Fowl bedding							X	X										Long-necked conifers
																		Chicken raisers, local
							X	X	X									Hardwood foliage, redwood and Douglas-fir bark
Nursery mulch																		Free of twigs, branches
																		Nurseries, local
Compost and fertilizer							X	X										do.
Spanish moss							X											Shellfish, packers, local
Bolts, Billets, Short Logs																		
Shingles	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	White pine, eastern cedars, cypress, southern pine, spruce, ponderosa pine, redwood, western redcedar, eastern hemlock, aspen, incense-cedar
																		Bolts 52 inches long or logs
																		Straight grain, free of shake, checks, rot (but hollow butts acceptable)
																		Shingle mills in South, East, Lake States, Northwest, California
																		Most shingles, except cedar and redwood, are used locally
Excelsior	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Cottonwood, aspen, basswood, southern pine, willow, yellow-poplar, white pine, sweetgum, red maple, hemlock, cedar, ponderosa pine, Douglas-fir, red pine
																		44 inch diameter, 37 and 56 inches long
																		Free of defects, reasonably straight
																		East, Lake States, Pacific Coast excelsior manufacturers
																		Bolts are recut to shorter lengths. By arrangement with manufacturer it should be possible to salvage and deliver shorter bolts
Plaster lath	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Softwoods and hardwoods
																		6-foot lengths or multiples
																		Nonstaining, available species required for plaster lath. Hard species acceptable for other uses
																		Sawmills, all regions
																		Can be produced in conjunction with box material
Cooperage lath	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	do.
Cooperage lath	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	do.
Cooperage heading, staves, hoops	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Elm, sweetgum, birch, beech, maple, red, white, and southern pine, chestnut, white oak, red oak, spruce, ash, tupelo, cottonwood, basswood, sycamore, hemlock, spruce, tamarack, Douglas-fir
																		8 inches by 4 feet and larger
																		Better quality material goes in to staves, lower quality into heading
																		Cooperage mills, sawmills having heading mills
																		Species used depend upon product to be shipped. For foods, wood used must not impart flavor or color

Table 1.--Physical uses of forest residue (continued)

Use	Material											Condition	Species	Sizes	Specifications, requirements	Purchasers, markets	Remarks					
	Unmerchantable	Thinnings	Tops	Branches	Stems	Bark	Foliage	Green	Dry	Rough	Peeled							Sawed	Split	Heaved		
Boxboard and crating	X	X	X	X				X	X									Many softwoods and hardwoods	Boits and logs	Lower grades of logs usually used	Sawmills	
Box veneer: sliced	X	X	X	X	X			X	X									Softwoods	Lengths 18 to 27 feet	Split or round material free of defect. Very small knots permitted	Veneer-box plants	Used at a few western mills
rotary	X	X		X				X	X									White fir	Diameter 12 inches +, length 36 inches	Clear	Box-veneer mills	Cut from tops between successive whorls of branches
Figured veneer: stump				X				X	X									Black walnut, black cherry			Fancy veneer mills	Fancy-grained material in high demand, usually sold by weight
crotch burl		X						X	X									do.			do.	do.
Laminated flooring		X	X	X				X	X									Walnut, redwood, birch, maple			Novelty manufacturers	
Construction																		Hardwoods				One plant makes laminated flooring, utilizing discard from low-grade logs
Cabin: hunting		X		X				X	X	X								Softwoods, oak	Usually 5 to 8 inches in diameter			
tourist buildings: foundations		X		X				X	X	X								Softwoods	do.			
punchona Arbors		X	X	X				X	X	X								Cedar, other conifers	2 to 6 inches in diameter	Sound, knots trimmed closely	Retail lumber yards	Straightness and good appearance desirable
Trellises		X		X				X	X	X								do.	1 to 2 inches in diameter	do.	do.	do.
Fencing: posts	X	X	X	X				X	X	X	X							Hardwoods, denser softwoods	2- to 6-inch top, 7 feet long	Durability	Railroads, farmers	Preservative treatment given most species
rails: farm, paddocks, and corrals	X	X		X				X	X	X	X							Cedar, chestnut, tamarack, other hardwoods and softwoods	Approximately 4 inches in diameter x 20 feet	Straight, easily split (for split rails)		
rails: rustic	X			X				X	X									Cedar, spruce				A field capable of substantial expansion, including catering, to interest in garden and lawn ornamental fencing

Table 1.--Physical uses of forest residue (continued)

Use	Material										Condition	Species	Size	Specifications, requirements	Purchasers, markets	Remarks			
	Unmerchantable	Thinnings	Tops	Branches	Scams	Stumps	Bark	Foliage	Green	Dry							Rough		
Pelings: round:	X	X									X	X	X	1 to 1-1/2 inch:	Straight, trimmed:				
split:	X	X									X	X	X	top diameter	clonely				
Corner ribs	X	X									X	X	X	1 to 1-1/2 inch:			Florists, novelty:		
											X	X	X	top diameter			shops		
											X	X	X				Majority used		
											X	X	X				in closed con-		
											X	X	X				dition		
Decorations																			
Pine cones															White, sugar, and knob:	Free of inner-	Florists, novelty:	Must be dry.	
															cone pine	fections, exces-	shops	Majority used	
																sive pitch		in closed con-	
																		dition	
Holly branches			X												Holly	Deep color,	Christmas tree		
			X													leaves numerous,	dealers		
			X													numerous berries			
Mistletoe															Mistletoe	Berries numerous	do		
Christmas trees		X													Fir, spruce, pines,	Heights 18	Unbroken top or	do	Summer and
															hemlock	inches to 9	leader, symmetri-	do	fall cuttings
																feet, a few to:	cal, dense	do	held in cold
																30 to 50 feet:	branches	do	storage
Pussy willow			X													Twigs 2 to 3 feet:			Springtime
			X													long, buds swollen			
Rhododendron															Rhododendron		Appalachians		Springtime only
Galax															Galax		do		Springtime only
Fancy Quatncks															California-laurel,	Blanks usually:	Gunsmiths and gun-		
															sugar maple roots	2-3/8 x 7 x 33:	supply stores		
																inches, dry,			
																free of knots			
																and checks			
Furniture																			
Upholstering																	Southeast Gulf		Pulled from
																	States		standing trees,
																			dried, and haled
Rustic		X									X	X	X		Cedar	1- to 4-inch		Cedar-specialty	
		X									X	X	X			diameter		manufacturers	
Picnic areas		X									X	X	X		Any	2- to 8-inch		Tourist parks	
		X									X	X	X			diameter			Usually made
		X									X	X	X						from material
		X									X	X	X						from the site
Logging Equipment																			
Measuring sticks		X									X	X	X		Any	None	Used on logging		Desirable to
Push poles		X									X	X	X		Softwoods, light hard-	2-inch top	Lightness, stiff-	operations only	use waste from
		X									X	X	X		woods	ness			merchantable
Cordwood stakes		X									X	X	X		do	3-inch top, 5		do	trees or parts
		X									X	X	X			to 6 feet long:		do	of unmerchantable
Scouts, sleds		X									X	X	X		Hardwoods, high-density		Resistance to		species. Young
		X									X	X	X		softwoods		wear		trees of merchant-
Truck stakes		X									X	X	X		Any	3 to 5 inches,	None	do	able species
		X									X	X	X			3 to 5 feet		do	should be reserved
		X									X	X	X			long		do	for future growth
Load tighteners		X									X	X	X		Any	2 to 4 inches,	None	do	unless damaged
		X									X	X	X			6 to 8 feet		do	
		X									X	X	X			long		do	
Cross hauls		X									X	X	X		Any		Straight pieces	do	Do
		X									X	X	X				desirable	do	
Rollways		X									X	X	X		Any		do	do	Quantities de-
Log decks		X									X	X	X		Any		do	do	pend on size
Booms, spars		X									X	X	X		Any		do	do	and type of
Machinery skids		X									X	X	X		Any		Straight, wear-	do	operation and,
		X									X	X	X				resistant	do	in the aggregate,
		X									X	X	X					do	may be large

Table 1.-Physical uses of forest residual (continued)

Use	Material										Condition					Species	Sizes	Specifications, requirements	Purchasers, markets	Remarks	
	Unmerchantable	Thinnings	Top	Branches	Stumps	Bark	Foliage	Green	Dry	Rough	Peeled	Sawed	Split	Beaved							
Logging Roads, Highways																					
Corduroy	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	Any	3 to 8 inches, moderate straightness	Self-consumed, usually taken from material cut along right-of-way	Same as for "Logging Equipment"	
Cribbing	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	Any	6 to 12 inches, moderate durability in temporary roads		Do.	
Culverts, drains	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	Any	4 to 8 inches, various lengths	do.	do.	Do.
Bridges, trestles	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	Hard species	Various	Straightness, strength	do.	Do.
Erosion control (brush) (baffles)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	Any	None	do.	Do.	
Guard posts	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	Stronger hardwoods, softwoods	Vary with purchaser	Straight, few knots. See specifications of buyers	Public highway departments throughout the country	Natural durability or ease of preservative treatments desired
Guard rails	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	do.	do.	do.	do.	
Sign posts	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	do.	do.	do.	do.	
Snow fence	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	Various	4-foot bolts, 5/4 inch diameter	Free of large knots and rot durable	Highway departments, farmers	Also used for corn storage bins
Mines																					
Sprags	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	Oaks, hickory, ash, sugar maple, beech, dogwood, hornbeam	2-1/4 to 3-1/4 inch diameter	Hardness and toughness, conical pointed ends	Coal mines	
Props	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	Hardwoods, softwoods	Diameter small	Specifications and under bark provided by mine operators	Mining operators	
Timbers	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	do.	10 to 30 feet long	do.	do.	
Mine ties	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	do.	Diameter small and under bark	do.	do.	
Mine rails	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	Hardwoods	Bolt 6-inch diameter, 5 feet long	do.	do.	
Novelties																					
Birch bark	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	Paper birch			Collected by users	Made into novelties by individuals
Balsam-fir pillows	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	Balsam fir			do.	Made into pillows by individuals

Table 1.--Physical uses of forest residue (continued)

Use	Material										Condition	Species	Size	Specifications, requirements	Purchasers, markets	Remarks					
	Unmerchantable	Trimmings	Tops	Branches	Stems	Stumps	Bark	Foliage	Green	Dry							Tough	Peeled	Sawed	Split	Shaved
Poles and Stakes																					
Electrical poles	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Some hardwoods, chiefly conifers	4 to 8 inch tops, 20 to 75 feet long	Straight, slow taper, sound, durable, or treatable	Treating plants, communication and power companies, railways	High percent butt-creosoted
Piling	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Hardwoods, heavy softwoods	Tops 8+ inches, 16 to 80 feet long	Straight, large butts, sound, durable, or treatable	Treating plants, railways, shipping companies	High percent fully creosoted
Bean poles	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Hardwoods and softwoods	Tops 1 to 1-1/2 inches	Straight, little taper, durable in soil	Truck growers, Hop growers, New York, California	Usually cut from own wood lot by farmer, but some are purchased
Tobacco-shade tent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Durable hardwoods and softwoods	5- to 9-inch tops, 10 to 12 feet long		Shade-tobacco growers, Connecticut	
Nursery-shade supports	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	do.			Nurserymen	
Oyster-bed stakes	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Eastern redcedar, Atlantic white-cedar	2- to 4-inch tops		Oyster growers	
Haystack poles	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Any	2- to 3-inch tops		Farmers	
Tree stakes	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Atlantic white-cedar	2- to 3-inch top diameter		City parks, landscaping companies	Supports for planted trees, streets, parks, and the like
Grape stakes	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	do.			Lumber dealers, vineyards, California, New York	
Converter poles	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Hardwoods				
Railways																					
Ties:																					
standard	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Hardwoods and denser softwoods	Bolts 10+ inches, 8 to 9 feet long	Specifications vary with purchaser. Specifications available from railway agents	Self-consumed on logging railways. Tie-logs purchased by sawmills; purchased by tie dealers and common carriers	Creosoting and use of tie-plates has permitted use of less durable and softer species
switch	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	do.	Lengths variable 10+ inch diameter, 6 feet long			
narrow-gauge	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	do.				
Car stakes	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Hardwoods, softwoods		Very soft wood not desired	Self-consumed	
Blocking and bracing	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	All lumber species	Various	Lower grades rough lumber	Sold through lumber dealers	
Loading-deck foundations	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	do.				
Water Transportation																					
Flume bents	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Locally available species used		Dependent upon size and type of construction	Used on logging operations only	Same as for "Logging Equipment"
Flume trestles	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	do.				
Splash-pond works and channel improvements	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	do.				
Log hoists	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	do.				
Raft construction	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	do.		As required by size and type of raft		

¹ May also be produced from solid sawmill residue.

Table 2.--Fiber uses of forest residue

Use	Material	Condition	Species	Sizes	Specifications, requirements	Purchasers, markets	Remarks
	Unmerchantable						
	Thinnings						
	Top						
	Branches						
	Stems						
	Bark						
	Green						
	Dry						
	Rough						
	Peeled						
	Chipped						
Boards	x	x	Various	Cordwood	Low-grade material suitable, but excessive rot undesirable	Masonite Corp., South	Wood reduced to chips at plant. A possible field for disposal of waste chipped in the forest
Masonite process	x	x	Various				
Cork	x	x	Douglas-fir		Bark of old-growth trees preferred		Cork from bark developed as war measure, not certain of continuation. Bark from pulpwood used as source
Fiberboard and Packing			Palmetto			Southeast	
Fillers	x	x	Douglas-fir, redwood				Bark from debarking of pulpwood or sawlogs can be processed into several types of fibrous products for use as fillers by process developed by Weyerhaeuser
Insecticide carriers	x	x	Redwood, Douglas-fir				Bark ground to fairly fine powder
Pulp	x	x	Various	4-inch diameter, various lengths 4 to 8 feet	Excessive rot not accepted. Excessive crook reduces solid volume of cord, lowers value	Pulp mills	Most promising and wide-spread market for woods waste of pulping species, but adjustments in prices must be expected because of lower solid volume per cord and greater bark and defect volume
Roofing or Saturating Felts	x	x	Various	Cordwood (re-cut to 2-foot lengths before processing)	Low-grade material suitable, but excessive rot undesirable	Roofing felt manufacturers	If arrangements can be made in Northeast and Midwest, structural recovery of waste can be increased and bulk handling developed
Fiberized wood	x	x	Various				
Asplund fiber	x	x	Various	Cordwood and chips	Low-grade material suitable, but excessive rot undesirable	Roofing felt, pulp board manufacturers	Wood can be chipped in the forest or at a landing and be shipped by truck or rail, using blowers for loading and unloading

Table 3.--Fuel uses of forest residue

Use	Material	Condition	Species	Sizes	Specifications, requirements	Purchasers, markets	Remarks
<u>Charcoal</u>	Unmerchantable						
	Thinnings						
	Top						
	Branches						
	Stems						
	Green						
	Dry						
	Rough						
	Split						
	Chipped						
	X	X	X	2- 5-foot lengths; maximum width of face, 6 inches	Free of serious rot; straight enough to permit close stacking	Must be coaled by owner. Fuel dealers, tobacco growers, car-heating companies, railways (dining car use), chemical firms, individuals	Special types of charcoal produced from special species such as willow. Distillation products recovered in some permanent plants, not saved in pit, cinder-block kiln, portable-steel-kiln methods. Can be saved with portable kerosene kiln. Charcoal is generally shipped in bags or bulk
<u>Local</u>							
			Sagebrush				Intermountain region
<u>Logging Operations</u>							
Cooking	X	X	X	Stove-wood size	Fast-burning species preferred	Used on logging operations only	Some substitution of coal and oil is occurring
Camp heating	X	X	X	Stove-wood size	Dense, heavy species preferred	Used on logging operations only	Some substitution of coal and oil is occurring
Donkey engines	X	X	X	4-foot lengths		Used on logging operations only	Obsolete uses - converting to coal or oil
Locomotives	X	X	X	4-foot lengths		Used on logging operations only	Obsolete uses - converting to coal or oil
<u>Sales to Dealers</u>							
<u>Users</u>							
Domestic	X	X	X	Stove and fireplace	Larger diameters usually split to 5-inch face	Wood and fuel dealers; direct consumers	Pine cones, dry; also used as kindling
Industrial processing (brass)	X	X	X	Cordwood	Larger diameters usually split to 5-inch face	Brass works	Used for annealing cartridge brass. Being replaced by gas with sulphur-eliminating accessories
<u>Public Utilities</u>							
Electric power	X	X	X	Douglas-fir		Only one utility (at Portland) operates on wood fuel, chiefly mill waste	Major portion of fuel used is mill refuse, but source of hogged wood is unimportant

Table 4. --Uses for production of chemicals from forest residue

Use	Material	Condition	Species	Sizes	Specifications, requirements	Purchasers, markets	Remarks
Derived Chemicals:							
Lignin					None (byproduct of other uses)		Byproduct of pulp processes
Acid, acetic	Unmerchantable	Chipped	Hardwoods	Cordwood		Wood-distillation plants	
Alcohol, methyl	Unmerchantable	Chipped	Hardwoods	Cordwood	Sound, excessive crook; wood-distillation undesirable	Wood-distillation plants	
Vanillin	Unmerchantable	Chipped					Synthesized from lignin
Carboxymethyl-cellulose	Unmerchantable	Chipped	Beech, fir, spruce, aspen	Pulpwood		Sylvania Division, American Viscose Corp.; Dow Chemical Co.; Hercules, Hopewell, Va.	Derived from pulp
Charcoal	Unmerchantable	Chipped					Produced in portable steel, kerosene, fixed cinder-block kilns, pits
Ashes	Unmerchantable	Chipped	All	Any	Not leached by exposure to rain	Fertilizer dealers, farmers, gardeners	
Extractives							
Tannins	Unmerchantable	Chipped	Chestnut, scrub oak, hemlock		Wood of chestnut, bark of scrub oak and hemlock	Extract plants	University of Florida has developed method for tannin extraction from chipped scrub oak
Dyes	Unmerchantable	Chipped	Osage-orange, black oak (Quercitron), sumac				
Oils	Unmerchantable	Chipped	Cedar, sweet birch, pine				Tall oils derived from sulfate pulping of pine
Canada balsam	Unmerchantable	Chipped	Balsam fir	Standing trees		Maine, New Hampshire, Vermont; 4 dealers in New York City, one in Maine	Over 90 percent supplied by Canada. Equal or better synthetic mountants developed during the war

Table 4.--Uses for production of chemicals from forest residue (continued)

Use	Material	Condition	Species	Sizes	Specifications, requirements	Purchasers, markets	Remarks
Naval stores	Unmerchantable Thinnings Tops Branches Stems Stumps Bark Polage Green Dry Rough Peeled Chipped		Longleaf pine	As found	Heartwood of high resin content	Steam-distillation plants in South	Stump areas owned and operated by owners of distillation plants
Ascorbic acid			Douglas-fir		Fresh green needles	One plant in Pacific Northwest	
Chlorophyll							Used as a deodorant
Gum			Spruce, Western larch, mesquite				Used as a confection
<u>Gases</u>							
Methane					Byproduct	Producer	Used for fuel in distillation process
Carbon dioxide			Any	Any	Byproduct	None	A potential use - one coal-burning power plant has successful carbon dioxide processing system
<u>Meat Smoking</u>			Denser hardwoods		Nonresinous	Meat and fish packers	Entire needs could be met by wood waste.
<u>Plastics</u>			Redwood, Douglas-fir bark				(Slabs, edgings, sawdust, and shavings also used)