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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	Top	Branches	Stems	Stumps	Dark						
								Green					
								Dry					
								Knug					
								Peel					
								Saw					
								Split					
								Head					
Bedding, Packing, Mulching													
Fowl bedding									Long-needled conifers			Chicken raisers, local	Usually collected by user from own or neighboring properties
Nursery mulch									Hardwood foliage, redwood and Douglas-fir bark		Free of twigs, branches	Nurseries, local	Do.
Compost and fertilizer									Hardwoods		do.	do.	Do.
Spanish moss												Shellfish, packers, local	Do.
Bolts, Billets, Short Logs, Shingles													
									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, and California	Most shingles, except cedar and redwood, are used locally
Excelsior									Cottonwood, aspen, basswood, southern pine, willow, yellow-poplar, white pine, sweetgum, red maple, hemlock, cedar, ponderosa pine, Douglas-fir, red pine	4+ inch diameter, 17 and 56 inches long	Free of defects, reasonably straight	East, Lake States; Pacific Coast excelsior manufacturers	Bolts are re-cut to shorter lengths. By arrangement with manufacturer it should be possible to salvage and deliver shorter bolts
Plaster lath									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									do.	do.	do.	do.	Do.
Cooperage lath									do.	do.	do.	do.	Do.
Cooperage - heading, staves, hoops									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	Size	Specifications, requirements	Purchasers, markets	Remarks
	Unmerchantable	Thinnings	Tops	Branches	Stems	Stumps						
							Log					
							Green					
							Dry					
							Rough					
							Peeled					
							Saved					
							Split					
							Heard					
Boxboard and crating	x	x	x	x	x	x	x	Many softwoods and hardwoods	Boils 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	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								Black walnut, black cherry			Fancy veneer mills	Fancy-grained material in high demand, usually sold by weight
crotch								do.			do.	do.
burle								Walnut, redwood, birch, maple			Novelty manufacturers	
Laminated flooring	x	x	x	x	x	x	x	Hardwoods				One plant makes laminated flooring, utilizing discard from low-grade logs
Construction												
Cabins: hunting	x	x	x	x	x	x	x	Softwoods, oak	Usually 5 to 8 inches in diameter			
tourist	x	x	x	x	x	x	x	Softwoods	do.			
Buildings: foundations											Chiefly logging camps	
punchons											do.	
Arbors	x	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	x	x	do.	1 to 2 inches in diameter	do.	do.	do.
Fencing: posts	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	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	Stems																
						Stumps	Bark	Foliage	Green	Dry	Rough	Peeled	Sawed	Split	Heaved						
Pelings: round:	X	X								X	X	X					1 to 1-1/2 inch: top diameter	Straight, trimmed: clonely			
split:	X	X								X	X	X					1 to 1-1/2 inch: top diameter				
Corncribs	X	X								X	X	X				Nonresinous				Wired pelings: form circular bin	
<u>Decorations</u>																					
Pine cones																White, sugar, and knob: cone pine		Free of inner: sections, excessive pitch	Florists, novelty: shops	Must be dry. Majority used in closed condition	
Holly branches				X				X								Holly		Deep color, leaves numerous, numerous berries	Christmas tree: dealers		
Mistletoe																Mistletoe	Sprigs	Berries numerous	do.		
Christmas trees		X						X								Fir, spruce, pines, hemlock	Heights 18 inches to 9 feet, a few to: 30 to 50 feet	Unbroken top or leader, symmetrical, dense branches	do.	Summer and fall cuttings held in cold storage	
Pussy willow				X													Twigs 2 to 3 feet: long, buds swollen			Springtime	
Rhododendron																Rhododendron			Appalachians	Springtime only	
Galax																Galax			do.	Springtime only	
<u>Fancy Gunstocks</u>																California-laurel, sugar maple roots	Blanks usually: 2-3/8 x 7 x 33 inches, dry, free of knots and checks	Gunsmiths and gun: supply stores			
<u>Furniture</u>																					
Upholstering																			Southeast Gulf States	Pulled from standing trees, dried, and baled	
Rustic		X		X					X		X	X				Cedar	1- to 4-inch diameter		Cedar-specialty manufacturers		
Picnic areas		X		X					X		X	X				Any	2- to 8-inch diameter		Tourist parks	Usually made from material from the site	
<u>Logging Equipment</u>																					
Measuring sticks		X							X		X	X				Any		None	Used on logging	Desirable to use waste from merchantable	
Push poles		X							X		X	X				Softwoods, light hardwoods	2-inch top	Lightness, stiffness	operations only		
Cordwood stakes		X		X					X		X	X				do.	3-inch top, 5 to 6 feet long		do.	trees or parts of unmerchantable species. Young trees of merchantable species	
Scoots, sleds		X		X					X		X	X				Hardwoods, high-density softwoods		Resistance to wear	do.		
Truck stakes		X		X					X		X	X				Any	3 to 5 inches, 3 to 5 feet long	None	do.	able species should be reserved for future growth unless damaged	
Load tighteners		X		X					X		X	X				Any	2 to 4 inches, 6 to 8 feet long	None	do.		
Cross hauls		X							X		X	X				Any		Straight pieces: desirable	do.	Do.	
Rollways		X							X		X	X				Any		do.	do.	Quantities depend on size and type of operation and, in the aggregate, may be large	
Log decks		X							X		X	X				Any		do.	do.		
Booms, spars		X							X		X	X				Any		do.	do.		
Machinery skids		X							X		X	X				Any		Straight, wear-resistant	do.		

Table 1.--Physical uses of forest residuo (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	Any	3 to 8 inches, road-width lengths	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	Any	6 to 12 inches, various lengths	Moderate durability in temporary roads		Do.
Culverts, drains	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	Hard species	Various	Straightness, strength	do.	Do.
Erosion control (brush) (baffles)	x	x	x	x	x	x	x	Any		None	do.	Do.
Guard posts	x	x	x	x	x	x	x	Any	2 to 6 inches, various lengths	Moderate straightness	do.	Do.
Guard posts (brush)	x	x	x	x	x	x	x	Any				
Guard posts (baffles)	x	x	x	x	x	x	x	Any				
Guard posts	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	do.	do.	do.	do.	Do.
Sign posts	x	x	x	x	x	x	x	do.	do.	do.	do.	Do.
Snow fence	x	x	x	x	x	x	x	Various	4-foot bolts, 5+ inch diameter	Free of large knots and rot	Highway departments, farmers	Also used for corn storage bins
Mines												
Sprags	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	Hardwoods, softwoods	21 inches long	Specifications provided by mine operators	Mining operators	
	x	x	x	x	x	x	x		6 to 8 inches, 10 to 30 feet long			
Timbers	x	x	x	x	x	x	x	do.	Diameter small end under bark	do.	do.	
	x	x	x	x	x	x	x		6 to 14 inches, 10 to 30 feet long			
Mine ties	x	x	x	x	x	x	x	do.	Bolt 6-inch diameter, 5 feet long	do.	do.	
Mine rails	x	x	x	x	x	x	x	Hardwoods	3 x 5 inches, 10 to 16 feet long	do.	do.	
Novelties												
Birch bark	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	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				
	Unmarketable	Trimings	Tops	Branches	Stems	Stumps	Bark	Foliage	Green	Dry	rough	peeled	sawed	split	blended					
Poles and Stakes																				
Electrical poles	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-cresoted
Piling	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 cresoted
Bean poles	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	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	do.			Nurserymen	
Oyster-bed stakes	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	Any	2- to 3-inch tops		Farmers	
Tree stakes	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				Lumber dealers, vineyards, California, New York	
Converter poles	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	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	Cresoting 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	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	do.				
Car stakes	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	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					
Water Transportation																				
Flume bents	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	Locally available		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	species used				
Splash-pond works and channel improvements	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	do.		do.	do.	do.
Log house	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	do.		do.	do.	do.
Raft construction	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	do.		As required by size and type of raft	do.	do.

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
Boards	Unmetchable						
	Thinnings						
	Top						
	Branches						
Masonite process	Stems						
	Bark						
	Green						
	Dry						
Cork	Rough						
	Peeled						
	Chipped						
Fiberboard and Packing							
Fillers							
Insecticide carriers							
Pulp							
Roofing or Saturating Felts							
Fiberized wood							
Asplund fiber							

Table 3.--Fuel uses of forest residue

Use	Material	Condition	Species	Sizes	Specifications, requirements	Purchasers, markets	Remarks
Charcoal	Unmerchantable						
	Thinnings						
	Top						
	Branches						
	Stems						
	Green						
	Dry						
	Rough						
	Split						
	Chipped						
Local			Hardwoods	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
			Softwoods				
			Sagebrush				Intermountain region
Logging Operations	Cooking			Stove-wood size	Fast-burning species preferred	Used on logging operations only	Some substitution of coal and oil is occurring
	Camp heating		Any	Stove-wood size	Dense, heavy species preferred	Used on logging operations only	Some substitution of coal and oil is occurring
	Donkey engines		Any	4-foot lengths		Used on logging operations only	Obsolete uses - converting to coal or oil
	Locomotives		Any	4-foot lengths		Used on logging operations only	Obsolete uses - converting to coal or oil
	Sales to Dealers						
	Users						
	Domestic		Any	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)			Cordwood	Larger diameters usually split to 5-inch face	Brass works	Used for annealing cartridge brass. Being replaced by gas with sulphur-eliminating accessories
	Public Utilities						
	Electric power						
Public Utilities							
Electric power							

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

Use	Material	Condition	Species	Sizes	Specifications, requirements	Purchasers, markets	Remarks
	Thinnings						
	Top						
	Branches						
	Stems						
	Stumps						
	Bark						
	Pollage						
	Green						
	Dry						
	Rough						
	Peled						
	Chipped						
Derived Chemicals:							
Lignin					None (byproduct of other uses)		Byproduct of pulp processes
Acid, acetic	x x x x	x	Hardwoods	Cordwood		Wood-distillation plants	
Alcohol, methyl	x x x x	x x x x	Hardwoods	Cordwood	Sound, excessive crook; undesirable	Wood-distillation plants	
Vanillin							Synthesized from lignin
Carboxymethyl-cellulose	x x x x	x	Beech, fir, spruce, aspen	Pulpwood		Sylvania Division, American Viscose Corp.; Dow Chemical Co.; Hercules, Hopewell, Va.	Derived from pulp
Charcoal	x x x x	x x					Produced in portable steel, kerosene, fixed cinder-block kilns, pits
Ashes	x x x x	x	All	Any	Not leached by exposure to rain	Fertilizer dealers, farmers, gardeners	
Extractives							
Tannins	x x x x	x	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			Osage, orange, black oak, (Quercitron), sumac				
Oils			Cedar, sweet birch, pine				Tall oils derived from sulfate pulping of pine
Canada balsam			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

(Sheet 1 of 2)

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

Use	Material										Condition	Species	Sizes	Specifications, requirements	Purchasers, markets	Remarks
	Unmerchantable	Thinnings	Tops	Branches	Stems	Stumps	Bark	Polage	Green	Dry	Rough	Peeled	Chipped			
Naval stores					x							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								x				Douglas-fir		Fresh green needles	One plant in Pacific Northwest	
Chlorophyll								x								Used as a deodorant
Gum												Spruce, Western larch, mesquite				Used as a confection
Gases																
Methane																
Carbon dioxide												Any	Any	Byproduct	Producer	Used for fuel in distillation process
																A potential use - one coal-burning power plant has successful carbon dioxide processing system
Meat Smoking	x	x	x	x					x	x		Denser hardwoods		Nonresinous	Meat and fish packers	Entire needs could be met by wood waste.
																(Slabs, edgings, sawdust, and shavings also used)
Plastics												Redwood, Douglas-fir bark				

(Sheet 2 of 2)