# USES FOR FOREST WASTE



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Increased attention is being directed toward the utilization of forest wastes in the interests of conservation and better business management. Information on the subject is being requested constantly of the Forest Products Laboratory by people in the forest and wood-using industries, by those who contemplate entering these industries, and by others interested in the conservation of timber supplies. For such information to be useful to the greatest number of inquirers, therefore, consideration of the problems involved necessitates the discussion of some aspects of waste utilization that are quite obvious to the experienced operator but less apparent to others.

The existence of forest waste is proverbial. Much of this waste is uncontrollable, yet a large portion of it is capable of reduction. Since 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 forest residue is often increased by poor operating practice or by mismanufacture, and some woods mismanufacture is the direct cause of waste in later stages of processing.

The total amount of 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 can minimize further waste of usable material. Some residues unsuited for one product may be usable for another; hence, 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 of 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

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too limited for low-cost handling. Costs of fuel or construction materials needed to replace residues sold reduce the gains from sale of waste. 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

It is a sound principle that the conversion of raw materials into their principal products is more profitable than the reworking of wastes into secondary products, because the market demand is usually greater for the principal products and they are in better form for efficient remanufacture. Within limits, then, it pays 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), to selection of log lengths that will eliminate crook, sweep, or grouped defects, and to placement of cuts to improve log grade and get 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 is recognized to have an important bearing on both waste prevention and salvage of waste. When the equipment is not adapted to the logging chance, or it is too heavy for the material handled, it may not be able to handle profitably 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, and 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 such single product 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 Waste

The woods operator has some opportunities to utilize waste in his own operation, as indicated previously. 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 of 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.

Unfortunately, there are no dealers purchasing woods waste for resale to a variety of users; the nearest approach to it is the retail fuel wood dealer. Both for the finished items made from waste (posts, ties, etc.) and the 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 waste 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 are exploitable, and in many products it is the mechanical and physical properties that are employed. Uses for mechanical properties are common-place. Waste wood 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 simply the extraction of 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 the utilization of forest waste will depend in large measure on the vigor and the business acumen of the individual management in adapting the program to the circumstances peculiar to the materials and location and on the seizing of temporary market opportunities as well as the finding of existing or the encouraging of new stable outlets. Best control of marketing obviously results from internal adjustments of the operation by which the needs of the operator can be met by using waste or lower-quality material to release better material for production, or by which secondary products from waste can be produced by the operator and marketed through the 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 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, since uses that are profitable in one region or under one set of circumstances may be money losers in another. Knowledge of conditions on the operation and of kinds and quantities of waste available, plus knowledge of nearby markets, is necessary to an intelligent choice of product to be made from the waste. To assist in such choice, the following tables 1-4 give, as fully as present information permits, a fairly complete list of uses for forest waste, with supplementary information on specifications, markets, consumption, and the like.

In column two of these tables the heading "Unmerchantable" applies to species of wood.

Table 1.--Physical uses of forest waste

| Use | Material: Merchantable logs | Material: Trimmings | Material: Tops | Material: Branches | Material: Stems | Material: Stumps | Material: Bark | Material: Foliage | Condition: Green | Condition: Dry | Condition: Rough | Condition: Peeled | Condition: Sawed | Condition: Split | Condition: Sawed | Condition: Chipped | Species | Sizes | Specifications, requirements | Purchasers, markets | Minimum load | Total consumption | Shipping: Require-ments | Shipping: Economical | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bedding, Packing, Mulching | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fowl bedding | | | | | | | | X | | X | | | | | | | Long-needled conifers | | | Chicken raisers, local | Wagon-load | Small | | Local | Usually collected by user from own or neighboring properties |
| Nursery mulch | | | | | | | | X | | X | | | | | | | Hardwoods | | Free of twigs, branches | Nurseries, local | | Small | | Local | Do. |
| Compost and fertilizer | | | | | | | | X | | X | | | | | | | do. | | do. | | | Small | | Local | Do. |
| Spanish moss | | | | | | | | X | | | | | | | | | | | | Shell fish packers, local | | Small | | Local | |
| Bolts, Billets, Short Logs | | | | | | | | | | | | | | | | | | | | | | | | | |
| Shingles | | | | X | | X | X | | | X | | X | | | | | White pine, eastern cedars, cypress, southern pine, spruce, ponderosa pine, redwood, Western redcedar, Western hemlock, aspen | 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 | | Medium | | | Most shingles, except cedar and redwood, are used locally |
| Excelsior | | | | X | X | X | | | | X | | X | | | | | Cottonwood, aspen, basswood, southern pine, willow, yellow-poplar, white pine, sweetgum, red maple, hemlock, cedar, ponderosa pine, Douglas-fir, Norway pine | 4-inch diameter, 37 and 56 inches long | Free of defects, reasonably straight | East, Lake States, Pacific Coast excelsior manufacturers | | Medium | None | Under 300 miles | Bolts are cut to shorter lengths. By arrangement with manufacturer it should be possible to salvage and deliver shorter bolts |
| *Plaster lath | | | | X | X | X | | | | X | | X | | | | | Softwoods and hardwoods | 4-foot lengths or multiples | Consisting, available species required for plaster lath. Hard species acceptable for other uses | Sawmills, all regions | | Medium | None | | Can be produced in conjunction with box material |
| *Snow-fence lath | | | | X | X | X | | | | X | | | | | | | do. | do. | do. | do. | | Medium | None | | Do. |
| *Corn-crib lath | | | | X | X | X | | | | X | | | | | | | do. | do. | do. | do. | | Medium | None | | Do. |
| *Cooperage - heading, staves, hoops | | | | 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 | 5 inches by 4 feet and larger | Better quality material goes into staves, lower quality into heading | Cooperage mills, sawmills having heading mills | | Medium | None | | Species used depend upon product to be shipped. For foods, wood used must not impart flavor or color |
| *Handles | | | | | | | | | | | | | | | | | See "Sawed Products", Forest Products Laboratory Report No. R1666-E | | | | | | | | |
| *Dimension stock | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Brush backs | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Sheathing and crating | | | | X | X | X | | | | X | | X | | | | | Many softwoods and hardwoods | Bolts and logs | Lower grades of logs usually used | Sawmills | | Large | None | | |
| Box veneer: sliced | | | | X | X | X | X | | | X | | X | | | | | Softwoods | Lengths 15 to 27 feet | Split or round material free of defect. Very small knots permitted | Veneer-box plants | | Small | None | | Used at a few western mills |
| rotary | | | | X | X | | X | | | X | | X | | | | | White fir | Diameter 12 inches + length 36 inches | Clear | Non-veneer mills | | Medium | None | | Cut from tops between successive whorls of branches |
| Figured veneer: stump | | | | | X | | X | | | X | | X | | | | | Black walnut, black cherry | | | Fancy veneer mills | | | | | Fancy-grained material is high priced, usually sold by weight |
| crotch | | | | | X | | X | | | X | | X | | | | | do. | | | do. | | | | | Do. |
| burls | | | | | X | | X | | | X | | X | | | | | Walnut, redwood, birch, maple | | | | | | | | |
| *Turning stock | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Eng. shade rollers | | | | | | | | | | | | | | | | | See "Sawed Products", Forest Products Laboratory Report No. R1666-E | | | Novelty manufacturers | | Small | | | Only one plant in operation making laminated flooring utilizes discard from low-grade logs |
| *Rungs, plugs | | | | | | | | | | | | | | | | | do. | | | | | | | | |
| *Paper cores | | | | | | | | | | | | | | | | | do. | | | | | | | | |
| *Spool stock | | | | | | | | | | | | | | | | | do. | | | | | | | | |
| Laminated flooring | | | | X | X | X | X | | | X | | X | | | | | Hardwoods | | | | | | | | |

*Items thus marked also may be produced from solid sawmill refuse.

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Table 1.—Physical uses of forest waste (continued)

| Use | Material: Merchantable | Material: Unmerchantable | Material: Trimmings | Material: Tops | Material: Branches | Material: Stems | Material: Stumps | Material: Bark | Material: Foliage | Condition: Green | Condition: Dry | Condition: Rough | Condition: Peeled | Condition: Sawed | Condition: Split | Condition: Hewed | Condition: Chipped | Species | Sizes | Specifications, requirements | Purchasers, markets | Shipping: Minimum lot | Shipping: Total consumption | Shipping: Requirements | Shipping: Economical distance | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Construction** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cabins: hunting | | X | | | X | | | | | X | | X | | | X | | | Softwoods, oak | Usually 5 to 8 inches in diameter | | | | | | | |
| tourist | | X | | | X | | | | | X | | X | | | | | | Softwoods | | | | | | | | |
| Buildings: foundations | | | | | | | | | | | | | | | | | | | | | Chiefly logging camps | | | | | |
| puncheons | | | | | | | | | | | | | | | | | | | | | do. | | | | | |
| steps | | | | | | | | | | | | | | | | | | | | | | Small | None | Local | | |
| walks | | | | | | | | | | | | | | | | | | | | | | Small | | | | |
| stalls | | | | | | | | | | | | | | | | | | | | | | Small | | | | |
| Arbors | | X | X | | X | | | | | | | | X | | | | | Cedar, other conifers | 2 to 6 inches in diameter | Sound, knots trimmed closely | Retail lumber yards | Small | 300 miles | Straightness and good appearance desirable | |
| Trellises | | X | | | X | | | | | | | | X | X | X | | | do. | 1 to 2 inches in diameter | do. | do. | Small | Local | | Do. | |
| Fencing: posts | X | X | X | X | X | | | | | X | | X | X | X | X | | | Hardwoods, denser softwoods | 2- to 6-inch top, 7 feet long | Durability | Railroads, farmers | 500 million | | | Preservative treatment given most species | |
| rails: farm, paddocks, and corrals | 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 susceptible of substantial expansion, including catering to interest in garden and lawn ornamental fencing | |
| palings: round | X | X | | | X | | | | | X | | X | X | X | | | | | 1 to 1-1/2 inch top diameter | Straight, trimmed closely | | | | | | |
| split | X | X | | | X | | | | | X | | X | X | X | | | | | | | | | | | | |
| Corncribs | X | X | X | | | | | | | X | | X | X | X | | | | Nonresinous | 1 to 1-1/2 inch top diameter | | | | | | Wired palings form circular bin | |
| **Decorations** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Pine cones | | | | | | | | | | | | | | | | | | White, sugar, and knobcone pine | | Free of imperfections, excessive pitch | Florists, novelty shops | | | | Must be dry. Majority used in closed condition | |
| Princess pine (fern) | | | | | | | | | | | | | | | | | | Princess pine (fern) | | Deep color, leaves numerous, numerous berries | Northeast Christmas tree dealers | | | | for Christmas wreaths | |
| Holly branches | | | X | | | | | | X | | | | | | | | | Holly | | | | | | | | |
| 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, asymmetrical, dense branches | do. | Truckload | Tops furnish very small percent | Pine in bundles | 500 miles | 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 |
| Fancy Gunstocks | | | | | | | | | | | | | | | | | | California laurel, sugar maple roots | Blanks usually 2-3/8 x 7 x 33 inches, dry, free of knots and cracks | Gunsmiths and gun-supply stores | | Small | Keep dry | Any | | |
| **Furniture** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Upholstering | | | | | | | | | | | | | | | | | | Spanish moss | | | Southeast Gulf States | | | Baled | | Pulled from standing trees, dried, and baled |
| Rustic | | X | | | X | | | | | X | | X | X | | | | | Cedar | 1- to 4-inch diameter | | Cedar-specialty manufacturers | Truckload | 2.5 million posts upper Michigan | 100 miles | | |
| Picnic areas | X | X | | | X | | | | | X | | X | X | | | | | Any | 2- to 8-inch diameter | | Tourist parks | | | | Usually ends from material from the site | |
| **Logging Equipment** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Measuring sticks | | | X | | | | | | | X | | X | X | | | | | Any | | None | | | | | | |
| Push poles | X | | X | | | | | | | X | | | X | | | | | Softwoods, light hardwoods | 2-inch top | Lightness, stiffness | Used on logging operations only | | | | Desirable to use waste from merchantable trees or parts of unmerchantable species. Young trees of merchantable species should be reserved for future growth unless damaged | |
| Cordwood stakes | X | | X | | X | | X | | | X | | | X | | | | | do. | 3-inch top, 5 to 6 feet long | | do. | | | | | |
| Scoots, sleds | X | | | | X | | | | | X | | | X | | X | | | Hardwoods, high-density softwoods | | Resistance to wear | do. | | | | | |
| Truck stakes | X | X | X | | X | | | | | X | | X | | | | | | Any | 3 to 5 inches, 3 to 5 feet long | None | do. | | | | | |
| Load tighteners | X | X | X | | X | | | | | X | | X | | | | | | Any | 2 to 4 inches, 6 to 8 feet long | None | do. | | | | Do. | |
| Cross hauls | X | | | | X | | | | | X | | X | | | | | | Any | | Straight pieces desirable | do. | | | | Do. | |
| Rollways | X | | | | X | | | | | X | | X | | | | | | Any | | | do. | | | | | |
| Log decks | X | | | | X | | | | | X | | X | | | | | | Any | | | do. | | | | Quantities depend on size and type of operation and, in the aggregate, may be large | |
| Booms, spars | X | | | | X | | | | | X | | | | | | | | Any | | | do. | | | | | |
| Machinery skids | X | | | | X | | | | | X | | X | | | X | | | Any | | Straight, wear-resistant | do. | | | | | |

Table 1.--Principal uses of forest waste (continued)

| Use | Material: Whole tree | Material: Main stem | Material: Tops | Material: Branches | Material: Stumps | Material: Bark | Material: Foliage | Condition: Green | Condition: Dry | Condition: Peeled | Condition: Sawed | Condition: Split | Condition: Treated | Condition: Chipped | Species | Sizes | Specifications, requirements | Purchasers, markets | Minimum lot | Total consumption | Shipping: Requirements | Shipping: Season | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Logging Roads, Highways** | | | | | | | | | | | | | | | | | | | | | | | |
| Corduroy | | 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 | | | Any | 6 to 12 inches, various lengths | Moderate durability in temporary roads | | | | | | do. |
| Culverts, drains | | 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) | | | X | X | | | | | | | | | | | Any | | None | do. | | | | | Do. |
| (baffles) | | | X | X | | | | | | | | X | | | Any | 2 to 6 inches, various lengths | Moderate straightness | | | | | | Do. |
| Guard posts | | 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 | | Moderate | 500 miles | Natural durability or some preservative treatment desired | Do. |
| Guard rails | | X | X | | | | | | | | | | | | | in. | do. | do. | | Moderate | do. | do. | Do. |
| Sign posts | | X | X | X | | | | | | | X | X | X | | | in. | do. | do. | | | do. | do. | Do. |
| Snow fence | | X | X | X | X | | | | | | X | | | | Various | | Tree of large knots and rot durable | Highway departments, farmers | Truck-load | Moderate | 50 miles | | Also used for corn storage bins |
| **Mines** | | | | | | | | | | | | | | | | | | | | | | | |
| Props | | X | X | X | X | | | | | | | X | | | Oaks, hickory, ash, sugar maple, beech, dogwood, hornbeam | 2-1/4 to 3-1/4 inch diameter, 21 inches long | Hardness and toughness, conical pointed ends | Coal mines | | Small | | | |
| | | | X | X | | | | | | | | | | | Hardwoods, softwoods | Diameter small end under bark 6 to 8 inches, 10 to 30 feet long | Specifications provided by mine operators | Mining operators | Truck-load or car-load | Large | None | 300 miles | |
| Timbers | | | X | | X | | | | | | X | X | | | do. | Diameter small end under bark 6 to 14 inches, 10 to 30 feet long | do. | do. | | Large | None | 300 miles | |
| Mine ties | | | X | X | | | | | | | X | | | | do. | Diameter small end under bark 6 to 14 inches, 10 to 30 feet long | do. | do. | | Large | None | 300 miles | |
| Mine rails | | | X | | | | | | | | X | | | | Hardwoods | Bolt 6-inch diameter, 5 feet long | do. | do. | | Large | None | 300 miles | |
| | | | X | | | | | | | | X | | | | do. | 3 x 5 inches, 10 to 15 feet long | do. | do. | | Large | None | 300 miles | |
| **Novelties** | | | | | | | | | | | | | | | | | | | | | | | |
| Birch bark | | | | | | X | | | | | | | | | Paper birch | | | Collected by users | | | | | Made into novelties by individuals |
| Balsam-fir pillows | | | | | | X | | | | | | | | | Balsam fir | | | do. | | | | | Made into pillows by individuals |
| **Poles and Stakes** | | | | | | | | | | | | | | | | | | | | | | | |
| Electrical poles | | X | X | X | | | | | | | X | X | X | X | Some hardwoods, chiefly conifers | 6 to 8 inch tops, 20 to 75 feet long | Straight, slow taper, sound, durable, or treatable | Treating plants, communication and power companies, railways | | Large | 10000 miles | High percent butt-creosoted |
| Piling | | 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 | | Large | 10000 miles | High percent fully creosoted |
| Bean poles | | X | X | X | | | | | | | X | X | | | Hardwoods and softwoods | Tops 1 to 1-1/2 inches | Straight, little taper, durable in soil | Truck growers | | Small | Local | Usually cut from own wood lot by |
| Hop poles | | X | X | X | | | | | | | X | X | | | do. | do. | do. | Hop growers, New York, California | | Small | Local | local farmer, but some are purchased |
| Tobacco-shade tent | | X | X | | | | | | | | X | X | X | | Durable hardwoods and softwoods | 5- to 9-inch tops, 10 to 12 feet long | | Rhode-tobacco growers, Connecticut | | Small | | |
| Nursery-shade supports | | X | X | | | | | | | | X | X | X | | do. | do. | do. | Nurserymen | | Small | | |
| Oyster-bed stakes | | X | X | | | | | | | | X | | | | Eastern redcedar, Atlantic white-cedar | 2- to 4-inch tops | | Oyster growers | | Small | | |
| Haystack poles | | X | X | | | | | | | | X | X | | | Any | 2- to 3-inch tops | | Farmers | | Small | | |
| Tree stakes | | X | X | | | | | | | | X | X | | | Southern white-cedar | 2- to 3-inch top diameter | | City parks, landscaping companies | | Small | | Supports for planted trees, streets, parks, and the like |
| Grape stakes | | X | X | X | | | | | | | X | X | | | | | | Lumber dealers, vineyards, California, New York | | Small | | |
| Converter poles | | | X | | | | | | | | X | | | | Hardwoods | | | | | Small | | |
| **Railways** | | | | | | | | | | | | | | | | | | | | | | | |
| Ties: standard | | 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. Ties logs purchased by railroads; purchased by tie dealers and common carriers | | | | Treesaving and use of tie-plates has permitted use of less durable and softer species |
| which narrow-gauge | | | X | X | | | | | | | X | X | X | X | do. | Lengths variable 10+ inch diameter, 6 feet long | do. | do. | | | | | |
| Car stakes | | X | X | | X | | | | | | X | X | | | Hardwoods, softwoods | | | Self-consumed | | | | | |
| Blocking and bracing | | | X | X | X | | | | | | X | X | | | All lumber species | Various | Very soft wood not desired. Lower grades rough lumber | Sold through lumber dealers | | Local-use | | | |
| Loading-dock foundations | | X | X | X | | | | | | | X | X | | | | | | | | | | | |
| **Water Transportation** | | | | | | | | | | | | | | | | | | | | | | | |
| Flume boots | | X | X | X | X | | | | | | X | X | | | Locally available species used | | Dependent upon size and type of construction | Used on logging operations only | | None | On the spot | Same as for "Logging Equipment" |
| Flume trestles | | X | X | X | X | | | | | | X | X | | | | | | | | None | | Do. |
| Splash-pond works and channel improvements | | X | X | | | | | | | | X | X | | | do. | do. | do. | do. | | None | do. | Do. |
| Log booms | | | | | | | | | | | X | X | | | do. | do. | do. | do. | | None | do. | Do. |
| Raft construction | | X | | | | | | | | | X | X | | | do. | do. | As required by size and type of raft | do. | | None | do. | Do. |

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Table 2.—Fiber uses of forest waste

| Use | Material: Unmerchantable | Material: Tailings | Material: Tops | Material: Branches | Material: Stems | Material: Stumps | Material: Bark | Material: Pulpwood | Condition: Green | Condition: Dry | Condition: Rough | Condition: Peeled | Condition: Sawed | Condition: Split | Condition: Hewed | Condition: Chipped | Species | Sizes | Specifications, requirements | Purchasers, Markets | Minimum lot | Total consumption | Shipping: Requirements | Shipping: Economical distance | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boards | | | | | | | | | | | | | | | | | | | | | | | | | |
| Masonite process | X | X | X | X | X | X | | | X | | X | | | | | | Various | Cordwood | Low-grade material suitable, but excessive rot undesirable | Masonite Corp., south | Truckload | Large | | | Wood reduced to chips at plant. A possible field for disposal of waste chipped in the forest |
| Cork | | | | | | | X | | X | X | | | | | | | Douglas-fir | | Bark of old-growth trees preferred | | Very small | None | | | Cork from bark developed as war measure, not certain of continuation. Bark from pulpwood used as source |
| Fiberboard and Packing | | | | | | | | | | | | | | | | | Palmetto | | | Southeast | Small | | | | |
| Fillers | | | | | | | X | | X | X | | | | | | | Douglas-fir; redwood | | | | Small | | | | Bark from debarking of pulpwood or sawlogs can be processed into several types of fibrous products for use as fillers by new process developed by Weyerhaeuser |
| Insecticide carriers | | | | | | | X | | X | X | | | | | | | Redwood, Douglas-fir | | | | Small | | | | Bark ground to fairly fine powder |
| Pulp | | X | X | X | X | X | | | X | | X | 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 | Truckload | Large | None | 300 miles | Most promising and widespread 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 | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fiberized wood | X | X | X | X | X | X | | | X | X | X | X | | | | | Various | Cordwood (recut to 2-foot lengths before processing) | Low-grade material suitable, but excessive rot undesirable | Roofing felt manufacturers, northeast and midwest. Structural board manufacturers | Truckload | Medium | None | | If arrangements can be made to deliver in 2-foot lengths, recovery of waste can be increased and bulk handling developed |
| Asplund fiber | X | X | X | X | X | X | | | X | X | X | X | X | | | X | Various | Cordwood and chips | Low-grade material suitable, but excessive rot undesirable | Roofing felt, pulp board manufacturers | Truckload | Medium | None | | 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 waste

| Use | Material: Unmerchantable | Material: Thinnings | Material: Tops | Material: Branches | Material: Stems | Material: Stumps | Material: Bark | Material: Foliage | Condition: Green | Condition: Dry | Condition: Rough | Condition: Peeled | Condition: Sawed | Condition: Split | Condition: Mixed | Condition: Chipped | Species | Sizes | Specifications, requirements | Purchasers, Markets | Minimum lot | Total consumption | Shipping: Required | Shipping: Economical distance | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Charcoal | x | x | x | x | x | | | | | x | x | | | | | | Hardwoods, softwoods | 2- 5-foot lengths; maximum width of face, 6 inches | Free of serious rot, straight enough to permit close stacking | Must be sealed by owner. Fuel dealers, tobacco growers, car heating companies, railways (dining car use), chemical firms, individuals | Bushel | Large | Bagged or in bulk | Any | 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 |
| Local | | | | | | | | | | | | | | | | | Sagebrush | | | Intermountain region | | Small | | | |
| Logging Operations: | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cooking | x | x | x | x | x | x | | | | | x | x | x | | | x | Any | Stovewood size: 4-foot lengths | Fast-burning species preferred | Used on logging operations only | | Small | None | Local | Some substitution of coal and oil is occurring |
| Camp heating | x | x | x | x | x | x | | | | | x | x | x | | | x | Any | Stovewood size: 4-foot lengths | Dense, heavy species preferred | Used on logging operations only | | Small | None | Local | Some substitution of coal and oil is occurring |
| Donkey engines | x | x | x | x | x | x | | | | | x | x | x | | | x | Any | 4-foot lengths | | Used on logging operations only | | Small | None | Local | Obsolescent uses - converting to coal or oil |
| Locomotives | x | x | x | x | x | x | | | | | x | | x | | | x | Any | 4-foot lengths | | Used on logging operations only | | Small | None | Local | Obsolescent uses - converting to coal or oil |
| Sales to Dealers, Users | | | | | | | | | | | | | | | | | | | | | | | | | |
| Domestic | x | x | x | x | x | x | | | | | x | x | x | | | x | Any | Stove and fireplace | Larger diameters usually split to 5-inch face | Wood and fuel dealers, direct consumers | Truckload | 60 millions cords | | | Pine cones, dry; also used as kindling |
| Industrial processing (brass) | x | x | x | x | x | x | | | | | x | x | x | | | x | Hardwoods | Cordwood | Larger diameters usually split to 5-inch face | Brass works | Truckcarload | Small total (large per user) | 50 to 200 miles | | Used for annealing cartridge brass. Being replaced by gas with sulphur-eliminating accessories |
| Public Utilities | | | | | | | | | | | | | | | | | | | | | | | | | |
| Electric power | | | | | | | | | | x | x | | | | | x | Douglas-fir now used; others acceptable | | | Only one utility (at Portland) operates on wood fuel, chiefly mill waste | Barge-truck-carload | | 100 miles | | Major portion of fuel used is mill refuse, but source of hogged wood is unimportant |

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

| Use | Material: Unmerchantable | Material: Thinnings | Material: Tops | Material: Branches | Material: Stems | Material: Stumps | Material: Bark | Material: Foliage | Condition: Green | Condition: Dry | Condition: Rough | Condition: Peeled | Condition: Sawed | Condition: Split | Condition: Mixed | Condition: Chipped | Species | Sizes | Specifications, requirements | Purchasers, markets | Minimum lot | Total consumption | Shipping: Requirements | Shipping: Economical distance | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Derived Chemicals** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Lignin | | | | | | | | | | | | | | | | | | None (byproduct of other uses) | | | | | | Byproduct of pulp and ethyl alcohol processes |
| Acids: acetic | | x | x | x | x | x | | | | x | x | | | | | | Hardwoods | Cordwood | | Wood-distillation plants | | | | | |
| lactic | | | | | | | | | | | | | | | | x | | | | | Small | | | Produced by fermentation of hydrolyzed wood |
| gluconic | | | | | | | | | | | | | | | | x | | | | | | | | Do. |
| mucic | | | | | | | | | | | | | | | | x | | | | | | | | Do. |
| Alcohols: ethyl | | x | x | x | x | | | | x | x | x | x | | | | x | Softwoods (Douglas-fir) | Any | Uniform chip size | None. One experimental plant in Oregon | | None | Local | Commercial market awaits results of current pilot-plant operation using mill waste |
| methyl | | x | x | x | x | x | | | | x | x | | | | | | Hardwoods | Cordwood | Sound, excessive crook undesirable | Wood-distillation plants | Truckload | | None | 50 to 100 mi. | |
| butyl | | | | | | | | | | | | | | | | | | | | | | | | | |
| Vanillin | | | | | | | | | | | | | | | | | | | | | | | | | Synthesized from lignin |
| 2-3 butylene glycol | | | | | | | | | | | | | | | | | | | | | | | | | |
| Furfural | | | | | | | | | | | | | | | | | | | | | | | | | |
| Carboxymethyl-cellulose | | x | x | 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 | | | | | x | x | | | | | | | | | Large | | | | Produced in portable steel, kerosene, fixed cinder-block kilns, pits |
| Ashes | | x | x | x | x | x | x | x | | x | | | | | | | All | Any | Not leached by exposure to rain | Fertilizer dealers, farmers, gardeners | | | Haggling process from rain | | |
| **Extractives** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Tannins | | x | x | 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, witch hazel | | | | | | | | Tall oils derived from sulphate pulping of pine |
| Canada balsam | | | | | | | | | | | | | | | | | Balsam fir | Standing trees | | Maine, New Hampshire, Vermont; 4 dealers in New York City, one in Maine | None. purchased by gallon | 1,000 gal. | | | Over 90 percent supplied by Canada. Equal or better synthetic countants developed during the war |
| 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 | | Very small | | | |
| Chlorophyll | | | | | | | | x | | | | | | | | | | | | | | | | | Used as a deodorant |
| Gum | | | | | | | | | | | | | | | | | Spruce, western larch, mesquite | | | | | | | | Used as a confection |
| **Gases** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Methane | | | | | | | | | | | | | | | | | | | Byproduct | Producer | | | | | Used for fuel in distillation process |
| Carbon dioxide | | | | | | | | | | | | | | | | | Any | Any | Byproduct | None | None at present | | | | A potential use - one coal-burning power plant has successful carbon dioxide processing system |
| **Meat Smoking** | x | x | x | x | x | x | x | | | | x | x | x | x | | | Dense hardwoods | | Nonresinous | Meat and fish packers | | Medium | | | Entire needs could be met by wood waste. (Slabs, edgings, sawdust, and shavings also used) |
| **Plastics** | | | | | | | | x | | | | | | | | | Redwood. Douglas-fir bark | | | | | Small | | | |

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