



U.S. DEPARTMENT OF AGRICULTURE • FOREST SERVICE
FOREST PRODUCTS LABORATORY • MADISON, WIS.

In Cooperation with the University of Wisconsin



**U.S.D.A. FOREST SERVICE
RESEARCH NOTE**

FPL-087

Rev. 1973

WOOD PRODUCTS MANUFACTURE AT SMALL SAWMILLS AND WOODWORKING PLANTS

Summary

Possible lines of manufacture and general requirements are summarized for various wood products from small sawmills and woodworking plants.

WOOD PRODUCTS MANUFACTURE
AT SMALL SAWMILLS AND WOODWORKING PLANTS¹

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In some rural areas, small sawmills play a significant role in the local economy. These sawmills not only furnish a market for farm woodlot timber but also provide a service to farmers in supplying lumber for construction and maintenance of farm buildings. In many instances, the livelihood of 10 or 12 families may directly depend on a single small sawmill operation.

It often happens, however, that the local market for his lumber is somewhat seasonal. As a consequence the small operator must reach out for more distant markets to keep his crew working full time. Since distant markets are more competitive, the profit margin dwindles. Therefore the sawmill operator frequently turns his attention to combining a wood products plant with his sawmill operation so he can fabricate finished or semi-finished products.

Requests are frequently received at the Forest Products Laboratory for information of this character, not only from operators of small sawmills but also from small timberland owners and others who desire to establish plants to utilize timber or residual material from logging and sawmilling operations.

The purpose of this publication is to aid those seeking such information. The publication emphasizes certain factors of business planning that are usually given too little attention, suggests some possible lines of manufacture, and briefly discusses equipment requirements. Sources for additional information are suggested including a list of references at the end of the note.

¹Slight revision of Note with the same title and designation, published in January 1965.

²Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

Fundamental Business Factors

Accumulated knowledge for operating a successful small wood products enterprise emphasizes the basic importance of adequate financing, management, raw material supply, and marketing possibilities. When the individual can satisfy himself that these are adequate, he can approach the dominant question of what to make and how to make it.

As he views this anticipated product from all angles, he must take an even closer look at the business fundamentals. What capital investment is necessary? How about operating costs? What volume of business is probable? Will the anticipated profits and volume of business meet his financial requirements? Is the manner of marketing the product on a sound basis? Obviously, no generalized answer can be given here. An attempt is made, however, to point out some main facts so the individual may work out the answers for his particular setup,

Capital Investment

The amount of capital required to operate profitably is fully as important as that required to establish the plant. Thus careful analysis is needed to insure that funds are adequate for operating expenses, for a reserve to meet unforeseen emergencies, as well as for purchase of facilities.

Because some lines of manufacture require a relatively small investment, they may be launched when inadequately financed, and poorly equipped and manned. This can result in fluctuating production and often an inferior product. Because consumers demand a constant and dependable supply of well-manufactured goods, they quickly lose confidence in an unstable plant and turn to more reliable sources, often to a larger plant in a distant area or to a substitute material.

Operating Costs and Accounting

Nearly 25 percent of the total operating costs of some small plants consists of such items as interest on capital, taxes, depreciation, and maintenance and repair of equipment. Only complete accounting will insure that indirect as well as direct operating costs are figured. For the small plant with limited personnel and facilities, bookkeeping can be reasonably simple, requiring primarily a systematic

recording of financial transactions. An excellent source of information in establishing a simplified system of record keeping is from the Agricultural Extension Service in each State. A simple system is also described in the U.S. Department of Agriculture Handbook No. 27, "Small Sawmill Operator's Manual.—A more sophisticated system is described in "A Cost-Accounting System for Small Sawmills" by James Whittaker.

Labor

In the small plant, either the plant owner or foreman may be skilled in machine setup, maintenance, filing and tool conditioning, and capable of training labor in the processes of manufacture.

Good labor is especially essential to the small plant because the small group must work as a team. While it is desirable to have experienced workers, the average worker often can be trained to do a variety of jobs requiring patience and skill. Thus, with only one member versed in the techniques of manufacture, it is possible to develop a trained crew fairly quickly.

Raw Material Requirements

Obviously an adequate wood supply is required to insure steady and continuous operation. Whether standing timber, lumber, or wood residue is to be the source of supply, the weak spot often is lack of knowledge as to the character, size, and amount available to meet the requirements of the product. For mill and woods residue, this may be determined from a careful study of the amount and kind available. For standing timber, a timber cruise may be necessary. Methods of estimating standing timber are described in U.S. Department of Agriculture Farmers' Bulletin No. 2187, "Managing the Family Forest." Often specific information about timber in an area is available from the office of the State Forester.

Selling

A factor of great importance, which often does not receive the attention it deserves, is the need for better market analysis and salesmanship. More time should be spent trying to find additional or better markets for the specific items that can be produced from the material available. Wood must meet the

³Citing of the publications suggested, and the source from which they are available, is given in the References at the end of this Note.

competition of other materials. When a plant owner searches out the markets for wood products of all kinds, determines which of these products can be produced and distributed by his own plant, and then goes out and sells them, progress is made.

Long lists of forest products are available, but the mere listing accomplishes little. Someone must act; first find a buyer for these products and then see that products are made and delivered at a cost mutually agreeable to producer and user.

Selling products for local use in a rural area involves contact with farm agencies, fruit and vegetable exchanges, farm foresters, and county agricultural extension agents to determine local needs. Likewise, the needs of local industries can be determined through purchasing agents or other buyers. Local advertising will keep the prospective consumer informed of the goods, services, and facilities available,

Lines of Manufacture

Products with good local demand and of simple construction are ideal for manufacture at a small plant. For farming areas the products may logically be those used in and for agriculture; for industrial areas, those involved in manufacturing enterprises. They may be products required in construction, in packaging and shipping produce and goods, or in making such products as handles, furniture parts, and miscellaneous turnings.

From the standpoint of simplicity, the amount of machinery required is important but the degree of drying required in the wood is even more of a factor. Products producible from roughly dressed green material, or even yard-dry material, are easy to undertake. But such products are so easy to make that competition is heavy and the margin of profit extremely small. Products involving thoroughly seasoned material and accurate machining require operators with more skill and experience and also a larger investment. But generally they meet with less competition and are likely to be more profitable.

In any case simple manufacture should not be confused with crude manufacture. Market prospects for crude manufacture are not promising.

In general the more refined the product, the larger the potential margin of profit. The newer or more glamorous products are often sought, but they are not necessarily the most profitable, particularly in the early stages of development.

If quality of material permits, refined building products are probably more profitable than rough factory dimension stock, and factory dimension more profitable than box and crating items.

The following classification may be of assistance in considering specific products in detail:

Square-edged items from green or yard-dry stock

Slat and lath products (fencing, vegetable and fruit crates, shook, industrial crates)

Lumber products (pallets, grain doors, cribs, bins, crating, car blocking)

Square products (stakes, handle, furniture turning, and dowel stock)

Patterned and shaped items from well-seasoned stock

Lumber products (agricultural implements and repair parts, prefabricated farm structures)

Turned products (handles, dowels)

Fabricated products (bed slats, lawn and garden furniture, play equipment, novelties, specialties)

Additional items to be considered in connection with the above classifications are contained in U.S. Forest Service Research Note FPL-038, "Uses for Slabs, Edgings, and Trims."

Equipment and Operating Requirements

It is generally recognized that a large plant has an advantage over a small plant when making the same product because the larger plant often has more and better equipment, can produce at a lower unit cost, and can operate on a smaller margin of profit.

However, the small plant has a chance to offset this advantage when it operates close to raw materials and close to markets. Small plants often can operate profitably where large plants cannot, particularly if the small plant is equipped with the proper machines and operates efficiently.

There can be no set pattern for accomplishing this because of the many variables of location, raw materials, markets, and the like. However, only a few standard machines and simple procedures are required to fabricate a wide variety of products.

The following paragraphs deal briefly with types of equipment and certain combinations of machines to make various products. The information is largely based on observation of plants that are being successfully operated in various sections of the country. This, together with personal experience and observation at other installations, should be of help to the prospective small plant owner in formulating plans for his own plant.

Milling Equipment

Plants obtaining their raw materials in the form of logs, bolts, or woods residue use some form of headsaw, usually one of the following types:

- (a) Standard circular mill, for sawing larger logs.
- (b) Bolter or short log mill, for small diameter logs less than 9 feet long (mill is patterned after the standard circular).
- (c) Shingle machine, for bolts less than 2 feet long.
- (d) Barrel heading saw, for bolts less than 2 feet long.

Cutup Equipment

Crosscutting saws and ripaws are the basic machines used in small cutup plants utilizing lumber and mill residue as raw material. These saws, in combination with surfacing machines, largely determine the production scope of the plant. While there is no standard combination of machines for any group of products, certain combinations are encountered often enough in small plants to indicate three general types:

Type 1 (Simplest equipment).--The simplest equipment consists of a cross-cut saw, ripaw, and for faster production a gang ripaw. This combination permits making such items as rough crating lumber, grain doors, car blocking, lath, and slat products. A slab resaw or a lath bolter saw is required when utilizing mill residue.

Type 2 (Medium equipment).--The medium amount of equipment consists of a jointer and planer plus the machines indicated for type 1. This combination permits making such items as pallets, box shook, and surfaced lumber items in addition to those in type 1. As some box shook requires side matching, this operation can be done with a light planer-matcher-molder substituted for the planer; this also permits fabrication of additional items, such as low-grade flooring and patterned items.

Type 3 (Full equipment).--Full equipment consists of dry kilns, gluing equipment, bandsaws, sanding equipment, drill press, and tilting table saw plus the equipment mentioned in types 1 and 2. This combination permits making core stock, furniture parts, farm implement repair parts, prefabricated farm structures, various specialties and novelties, and a wide variety of other finished and semifinished products.

Equipment is required to handle and convey materials in and around the plant in all of these groups. This may range from factory trucks to conveyor belt systems.

Shop-type machines of medium weight are best suited for the small plant although light, portable equipment may be practical for a limited amount of light work.

Production Methods

Efficient production methods are generally considered the key to successful plant operation. These include placing machinery and equipment in proper relation to each other to eliminate unnecessary lifting, carrying, and backtracking of materials. Of considerable importance in this respect is an analysis of the product to be made. Such an analysis will indicate the machine requirements as well as the number, size, and form of the individual parts of the product. This analysis will be of value in determining the most economical form, size, and grade of raw material to use.

Of obvious importance to the efficient operation of a plant is proper machine maintenance, sharpness of saws and cutter knives, and correct machine speeds. A recognized reference on this subject is "Hanchett's Saw and Knife Fitting Manual." Manufacturers of saws and knives also are sources of information on such care.

Products and Methods of Manufacture at Typical Plants

A brief description follows of the methods observed at representative small plants for making products of the types discussed. The description is supplemented with additional information pertaining to general industry products, specifications, and the like.

Slat Products

Slat products are usually produced directly from short logs or bolts rather than from lumber of standard size.

Vegetable, fruit, and perishable food shipping and storage containers,--This class of products is about the simplest to make, consisting primarily of rough sawed slats and cleats. Specifications for them vary considerably, each locality or community generally having its own. The species used and the commodity to be shipped influence the sizes of the individual pieces. Slats are 1/2 to 5/8 inch thick and 2 to 5 inches wide; cleats are 1 by 2 inches in cross section. Squares and corners are often 1-inch-square stock. The wood is green or yard-dry depending on the use. Grade is unimportant as knots and discolorations have little effect on the use.

Definite specifications for shipping containers applicable to rail shipments are set up by the Association of American Railroads.

Practically all commercial wood species are used for shipping and storage containers, except that those imparting flavor or odor to the contents are not used for some food products. In the West the pines, firs, and spruces are most commonly used. In the East and South both hardwoods and softwoods are used. In the Central States and in the North, hardwoods predominate, the common species being elm, soft maple, gum, beech, basswood, cottonwood, sycamore, aspen, and Oak.

For this group of products the following examples are cited:

Celery shipping crates were part of the production at one small mill. Here good and poor logs were segregated at the sawmill, with poorer logs being cut into slat products and the better logs into lumber. The slats were made from sawed flitches. The plant produced 25,000 crates and about 150,000 board feet of lumber per year with four men, using a standard circular sawmill plus a swing cut-off saw, gang rip saw, bundle-tying equipment, and large-wheeled factory dollies. Logging was done in the winter. The high-grade logs were separated and sawed first in the spring months into graded lumber. The low-grade logs were sawed into flitches of the thickness required for the width of the crate slats. These were crosscut to the length required at the swing cut-off saw and piled on the dollies. The pieces were then ripped on the gang rip saw into slats of the desired thickness, and passed directly to the bundling table, bundled into convenient 5-crate bundles, and stacked for shipment. No trimming was necessary. The plant was completely housed in a 28- by 70-foot building the sawmill at one end

and the fabricating machines at the other. A space of about 20 by 24 feet was used for stacking material and bundles. No extra storage space was required as crates were shipped immediately.

Vegetable and fruit field and storage crates were the product of another mill. Here a heading saw was used as the main breakdown equipment for producing slats from bolts and short logs. With five men, this plant produced 150,000 crates per year from about 1,000 cords (500,000 board feet) of small logs or bolts purchased from local farmers. A pendulum-type heading saw was used with a swing cut-off saw, gang rip-saw, bundle-tying machine, large-wheeled factory and yard dollies, and yard tractor,

Bolts hauled from the storage yard were crosscut on the swing cut-off saw into short billets of the lengths required for the individual parts. These billets were placed in the pendulum-type carriage of the heading saw and cut into thin flitches of the thickness required. These flitches were piled on a wheeled dolly, hauled to the drying yard, and piled for drying. Each size and thickness was piled separately. Proper piling methods are extremely important to this type of operation,

After drying, these unedged flitches were hauled from the yard to the gang rip-saw and ripped into slats and cleats of the desired widths. They were then stacked on the dollies ready for bundling. Bundles were of convenient handling size, such as pieces for five crates. They were trimmed to exact length on the swing cut-off saw, which was provided with a false bed for this purpose. Shipping was immediate so that extra storage space was not required other than the 3 acres required for the drying yard. A building 25 by 50 feet housed all equipment, and provided extra work space.

Fish boxes were produced by a third plant of this class. This mill used a short log headrig and short logs or bolts as raw material. The plant employed seven men and produced about 18,000 boxes per year from about 130,000 board feet of short logs or bolts purchased from local farmers. A short log sawmill or bolter was used, together with a swing cut-off saw, gang rip-saw, belt conveyor, and assembly jig benches.

Bolts were hauled from the yard and stacked adjacent to the bolter. On the bolter they were slabbed three sides to the thickness required for the shook width for sides, bottoms, tops, and ends. The 3-sided cants were stacked next to the swing cut-off saw to be cut to the required lengths. When cut to length the cants were stacked next to the gang rip-saw, ripped into thin shook, and dropped to a belt conveyor. The conveyor carried the pieces to the second floor where they were piled for drying. Slabs were resawn into cleats on the gang rip-saw, and

stored the same as the shook, After air drying the parts were returned to the first floor and nailed into boxes on assembly jig benches arranged around the outside wall. A nearby packing plant took the boxes as assembled; thus no storage space was required other than the 1 acre required for log storage. The building used was about 35 by 55 feet, the remaining floor space being sufficient for air drying and shook storage.

Snow fence lath, at the rate of 20,000 per day, were produced by six men at another plant. They used a machine which combines a bolt headsaw rig, heavy gang rip saw, and a lath machine. In addition a bundle-tying cradle and an equalizer trim saw were used. Bolts were slabbed two sides, and fed into the gang rip saw, which sawed them into flitches 1-1/2 inches thick. The flitches passed through the lath machine and were sawed into slats 1/2 inch thick, which were piled next to the bundle-tying machine. After bundles were tied, they were trimmed to length on the equalizing trim saw and sent to the storage yard for seasoning. The bundles were piled crib fashion for quick drying,

The slats used in this product were generally 1/2 inch thick, 1-1/2 inches wide, and 48 inches long. They usually had not more than three knots of 3/4-inch diameter (or their equivalent in smaller knots) well scattered. Slats were made from logs, bolts, and from residue incident to lumber manufacture. Most commercial wood species could be used except those that tend to warp badly when haphazardly dried. Dense woods were seldom used because they make fence rolls too heavy.

Weaving the lath into fencing entailed feeding slats into a machine between five double strands of wire. The machine put a twist in the wire between adjacent slats (spaced 2 inches apart); the finished fencing passed through a tank of paint and was rolled into bundles. Each roll was cut according to the length desired and was then ready for distribution.

Lumber Products

Simple products machined or fabricated from lumber comprise another important group, of which only a few items will be mentioned,

Grain doors. --Grain doors supplement railroad car doors in grain shipment. They are double thickness panels 20 inches by 7 feet in size and made of rough 1-inch boards of grades below No. 2 Common selected more for grain tightness than for strength.

Although softwoods are generally used, practically any species may be used, either green or air dried, depending on demand.

At one small mill producing 8,000 board feet of lumber per day, three men, other than the mill crew, made 200 grain doors per day from about 5,000 feet of lumber. Equipment other than the sawmill consisted of a swing cut-off saw, bench rip saw, bench assembly jigs, and lumber dolly. For fabricating the doors, lumber was piled from the headsaw to the lumber dolly. One man hauled it to the cut-off saw, cut it into the various lengths required, and piled them into adjacent open-end bins. On the opposite side of the bins two men assembled these pieces on jig benches and nailed them into assembled panels. The completed doors were piled ready for transportation or storage. Boards were ripped to assembly width on the rip saw as needed,

Pallets.--Pallets are portable platforms, used with lift trucks, upon which materials are placed so the unit can be conveniently handled and stored. A considerable market exists because many large industries, as well as small factories, have converted to this method of materials handling. It is a highly competitive product, usually netting only a slim margin of profit,

There are numerous types of pallets, including the simple rectangular skid type used in paper mills, the type with upright members, or the flat type with bottom and top decking.

Green or partially air-dried stock is generally used although some special pallets are made of dry stock. Grades No. 2 Common and lower are generally used but some consumers request a higher grade product. Planing, jointing, chamfering, or other machine work are required on most types. Deck boards may be 3/4- to 2-inch lumber, while skids, stringers, and upright members may be dimension lumber. Parts are fastened together with nails and screws, and in some cases glue is used. The size, number, and location of fasteners are very important in pallet construction. Some information on fasteners is contained in Agriculture Handbook No. 160, "Nailing Better Wood Boxes and Crates."

Practically all species are used although hardwoods, such as oak, elm, hickory, and gum, are preferred for stringers and some deck boards. Additional information is contained in Forest Service Research Note FPL-0213, "Wood Pallet Manufacturing."

Observations at one pallet plant showed that about 26,000 units were made annually from two million board feet of lumber. These units include small industrial pallets, small industrial boxes, and industrial crating.

A crew of 10 men logged, yarded, sawed, and piled the lumber required, all from locally grown species. A crew of 14 men operated the fabrication plant, the equipment consisting of a cut-off saw, rip saw, table cut-off saw (equipped to mount dado saws), planer, jointer, bundle-tying equipment, lift truck, and a yard truck.

Lumber was hauled from the yard, put through the planer, and piled next to the cut-off saw. The boards were cut to length, and piled adjacent to the rip saw. When ripped, the pieces were placed on skid pallets according to lengths, widths, and thicknesses. Pieces requiring notching were moved to the dado saw (table rip saw) and pieces requiring chamfering to the jointer. Materials were conveyed on skid pallets with a lift truck. Nailing was done on assembly jig benches, each worker hauling his own parts and stacking the assembled pallets.

The industrial crating at this plant was produced similar to pallets, eliminating the dado, chamfering, and nailing operations, and with the individual pieces being bundled for shipment. The procedure followed for boxes of this plant was similar to that for the crating, through the rip saw operation. Boxes and crating were minor items and served to fill in between orders for pallets. Boxes were assembled as orders were filled.

A building 48 by 55 feet in size housed the fabricating equipment, and provided storage. About 3-1/2 acres provided storage for logs and lumber. The sawmill was not sheltered. The plant discussed here represents a larger investment than previous examples, but it originated as a plant similar to the one discussed for making celery shipping crates.

Small prefabricated farm buildings and farm implement repair parts. --Pre-fabricated structures and parts present an opportunity to utilize farm timber for local use. A knowledge of good building construction methods, however, is necessary for making the small farm structures. For making equipment repair parts it is essential to know the types of farm equipment in use in the area.

Small prefabricated farm structures include chicken houses, brooder and shelter houses, corn cribs, and small barns. The design of these buildings may be patterned after farm building designs recommended by the State Agricultural college or well-designed structures in use in the vicinity. The larger structures can be made in sections and the smaller buildings may be completely assembled. All stock should be thoroughly dried.

Farm implement repair parts include wagon and truck boxes, truck beds, and harrowbeams. These repair parts are usually rough cut from green stock according to definite patterns and are thoroughly dried, usually 4 to 8 months in well-ventilated shed-type storage. The final machining may not be done until the individual repair job is done.

A wide variety of species can be used for most of these products. For farm buildings, strength is an important factor in structural members. Some general information is available in U.S.D.A. Leaflet 481, "Selecting Farm Framing Lumber for Strength."

One plant in a rural community integrated logging, milling, and manufacturing in making farm buildings and farm implement repair parts. About 250,000 board feet of local timber was logged and sawed each year, of which about 75,000 board feet was used for implement repair stock and 175,000 board feet for small farm structures. In addition to the logging and milling equipment, a planer-matcher-molder, jointer, swing cut-off saw, radial cut-off saw, table rip saw, drill press, band saw, small hand lathe, assembly jig benches, lumber buggy, small hand tools, and various hardware were required for fabrication. A crew of four men logged, sawed, and fabricated the small buildings, and three men made the implement repair parts and repaired farm equipment.

Logging was conducted to prepare material for farm implement stock cut to length and logs cut to the best advantage for building construction.

Rough blanks for implement stock were sawed on the headsaw, stored for drying, and finished on the individual job.

In the building fabrication operation, the stock was hauled from the drying yard, and the lumber and dimension for studding, rafters, siding, roof boards, and the like were surfaced for uniform size. These were cross cut to length according to cutting bills prepared in advance. Necessary miter cuts were made in this operation. The parts were separated in racks according to size and use. In assembly, parts were arranged on large flat-top jig benches having cleats spaced and fixed for several sizes of assemblies. Some parts required side matching and simple machine work, which was done on the small planer-matcher-molder. One man assembled the parts on the jig benches and two men nailed them. Finished sections were stacked for future assembly. Small barns were pre-cut and assembled on the barn site. A 25- by 50-foot building housed the fabricating machinery, the second floor providing loft space for further air seasoning of implement stock. About 1 acre of yard space was provided for initial seasoning. No yard space was required for log storage as sawing was done in the woods.

Products from Rough, Small Dimension

Rough, small dimension readily lends itself to manufacture at the small plant because of the relatively low investment involved, but requires accurate sawing and correct seasoning practices. Furniture dowel, handle, and turning squares are most commonly referred to as rough small dimension but the term includes other furniture and specialty parts as well as parts used in making crates and the like.

Specifications vary according to the individual uses.

The major species used are the hardwoods, such as oak, maple, gum, birch, hickory, and walnut in the East, and the softwoods, Douglas-fir and the pines, in the West. In the West small dimension is generally referred to as "cut stock."

The equipment and methods used at small plants are similar to those indicated for the small sawmill setup discussed for celery shipping crates. The material is sawed into flitches of the desired thickness, which are resawn into small dimension stock on the gang rip saw. These pieces are piled for air seasoning before bundling. Storage for drying is under a shed and the ends of the pieces are coated to prevent end checking. Logically, the manufacture of crates and high-grade small dimension could be done at the same point.

Finished or semifinished kiln-dried small dimension is distinctly different from the rough dimension referred to here. While possible to manufacture at fairly small plants, the high investment in equipment required for finished and semifinished small dimension generally eliminates it from consideration.

Other Sources of Information

The Carbondale Research Work Unit of the North Central Forest Experiment Station, U.S. Forest Service, Carbondale, Ill., has information for fabricating certain types of wood products suitable for manufacture at plants with medium or full equipment. This project was established in cooperation with Southern Illinois University to increase the industrial utilization of area timber, most of it hardwood species.

A number of State conservation departments have in recent years employed a forest products utilization specialist. He has the responsibility of helping wood products manufacturers with their problems and encouraging the establishment

of new plants. Information concerning the services of these forest products utilization specialists can be obtained from the State offices concerned with conservation of the State's resources.

The Forest Products Marketing Laboratory, Northeastern Forest Experiment Station, U.S. Forest Service, Princeton, W.Va., established to study problems of forest products marketing, is a source of information along this line. Many States have extension foresters who likewise can give advice on forest products markets at a more local level. Their offices usually are located at the State agricultural college or university.

A publication that presents further information on wood products for various uses is USDA Agriculture Information Bulletin 311, "Selection and Use of Wood Products for Home and Farm Building."

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