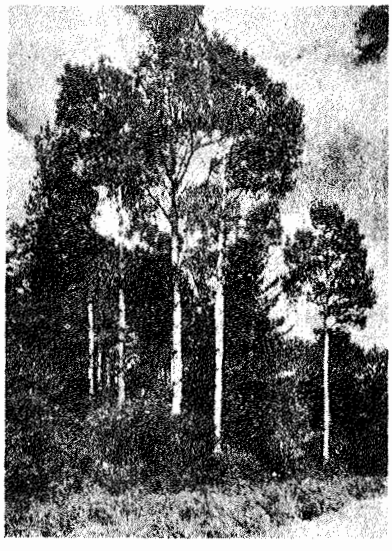
LAKE STATES ASPEN REPORT NO. 9

ASPEN LUMBER FOR BUILDING PURPOSES

BY
LOUIS W. REES
MINNESOTA AGRICULTURAL EXPERIMENT STATION
UNIVERSITY OF MINNESOTA



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FOREWORD

During and since World War II, there has been increasing interest in aspen (*Populus tremuloides*) in the Lake States, its availability and supply, properties and uses, and management. Aspen is a tree of primary importance in 20 million acres or 40 percent of the total forest area of the three Lake States - Michigan, Minnesota, and Wisconsin.

At an informal meeting at Madison, Wisconsin, in January, 1947, forestry representatives of several federal, state, and industrial groups in the Lake States agreed that it would be desirable to bring up-to-date what is known on aspen and make it available to anyone interested. The job of preparing this information in the form of reports was assigned to each of the groups listed below. The reports will be duplicated as rapidly as completed, and the entire project should be finished by the end of 1947. Each report will concern one aspect of the subject. Copies will be available from the Lake States Forest Experiment Station or from each contributor.

Report Number	Subject
1	Aspen Properties and Uses
2	Aspen Availability and Supply
3	Logging Methods and Peeling of Aspen
4	Milling of Aspen into Lumber
5	Seasoning of Aspen
6	Aspen Lumber Grades and Characteristics
7	Mechanical Properties of Aspen
8	Machining and Related Properties of Aspen
9	Aspen Lumber for Building Purposes
10	Aspen for Containers
11	Aspen for Core Stock
12	Small Dimension and Other Industrial Uses of Aspen
13	Aspen for Veneer
14	Aspen for Pulp and Paper
15	Aspen for Cabin Logs
16	Aspen for Excelsior
17	Aspen Defiberization and Refining of Product
18	Chemical Utilization of Aspen
19	Preservative Treatment of Aspen
20	Marketing of Aspen
21	Possibilities of Managing Aspen
22	Enemies of Aspen

Contributors of Lake States Aspen Reports

Lake States Forest Experiment Station, St. Paul 1, Minn.
Forest Products Laboratory, Madison 5, Wis.
North Central Region, U. S. Forest Service, Milwaukee 3, Wis.
Div. of Forestry, Univ. of Minnesota, University Farm, St. Paul 1, Minn.
School of Forestry and Conservation, University of Michigan, Ann Arbor, Mich.
Department of Forestry, Michigan State College, East Lansing, Mich.
Michigan College of Mining and Technology, Houghton, Mich.
Superior Wood Products, Inc., Duluth 2, Minn.
Forestry Agent, Chicago & North Western Railway System, St. Paul 1, Minn.

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AGRICULTURE - MADISON

REPORT NO. 9

ASPEN LUMBER FOR BUILDING PURPOSES

By

Louis W. Rees, Associate Forester
Minnesota Agricultural Experiment Station
University of Minnesota

INTRODUCTION

Recent shortages of lumber for building purposes make it desirable to seek out all possible supplies of additional lumber. Aspen, according to a study made in northern Minnesota during 1944,[1] may be a source of lumber largely untapped. The results of that study are the main basis of this paper.

In the past, aspen has received little consideration as a source of lumber, largely because of the small-sized trees often harvested and some prejudice against the wood. However, because it is abundant and has many favorable characteristics, aspen can be used much more widely for lumber.

Quaking aspen, Populus tremuloides Michx., has the widest range of any North American tree species. Bigtooth, Populus grandidentata Michx., while less abundant, often grows with quaking aspen. The wood of both species is marketed as aspen or "popple." Although the aspens grow on a wide variety of soil and site conditions, it is only on the best sites that they reach sawlog size.

The main stands of aspen are located in the Lake States, the northeastern United States, and in the central Rocky Mountain region. In the Lake States, there are 20 million acres of aspen type with a total saw-timber stand of nearly 6½ billion board feet. Of this amount, about one-half is located in Minnesota. Full utilization of the aspen stands for all the products they can produce can greatly improve the general prosperity of the Lake States forest area.

CHARACTERISTICS OF ASPEN LUMBER THAT AFFECT ITS USE FOR CONSTRUCTION PURPOSES

Physical Properties[2]

The fresh wood of aspen is normally white in color. On exposure it becomes grey or a pale grey-brown. The wood at the center of the tree is often discolored, and this discolored wood is often mistaken for

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1/ Conducted by the writer as a cooperative study between the Minnesota Agricultural Experiment Station and the Lake States Forest Experiment Station.

2/ See Lake States Aspen Report No. 1 for a more detailed discussion.

heartwood. Knots are numerous, comparatively small, generally tight, and often surrounded by discolored wood which makes the knot appear larger than it actually is. While knots decrease the strength of wood, these defects along with various discolorations are not objectionable for certain uses in building construction. However, wood containing decay should not be used.

Aspen lumber is easily air seasoned or kiln dried, but there is some loss from collapse in kiln drying. The collapse occurs primarily in the areas of discolored or brown-stained wood. Lumber up to 2 inches thick, properly piled and air seasoned, is satisfactory for most building purposes. Lumber that is piled during the winter or early spring should be ready for use in building construction in late summer and early fall of the same year. Since the lumber is often subject to warping and twisting during the drying process, the importance of good piling practice cannot be overemphasized.

Perhaps some of the other properties of aspen wood can best be brought out by comparison with a well-known structural wood such as eastern white pine. At 12 per cent moisture content, aspen is slightly heavier than eastern white pine. It has more shrinkage than eastern white pine, but less than that of many other woods used for similar purposes. With improper seasoning, as for most other woods, shrinkage may be considerable (see figure 1).

Figure 1.--The white streaks show the amount of shrinkage in green aspen bevel siding after one year of service. It is also evident that the overlap was not sufficient. The foundation is too low to protect the lower courses of boards from ground moisture. Photo by Forest Products Laboratory.

Mechanical Properties[3/]

Aspen wood has lower nail-holding power than that of eastern white pine. Soft woods, such as eastern white pine and aspen do not split readily during nailing and more or larger nails can be used. This will tend to overcome, at least in part, low nail-holding ability. However, the size of the nail should not be increased to the point where it will cause the wood to split. In one locality in northern Minnesota it was believed that the nail-holding power of aspen was greater than that of eastern white pine or red pine. Consequently, in constructing gothic sawed rafters, aspen wood was used at the center while the red pine boards were nailed to either side. The position of the two woods should have been reversed. The loss in nail-holding power when green aspen is used and allowed to season in place is greater than that for most woods and may be as much as 90 per cent. Loss in nail-holding power and the amount of shrinkage which occurs during seasoning are both good arguments for the proper seasoning of the material before use.

In static bending, a property important in beams, joist, and rafters, aspen is about equal to eastern white pine. Its stiffness and compression parallel to the grain are somewhat less, while its shock resistance or toughness is greater than that of eastern white pine. All of these properties are important in structural woods.

Durability and Paint-holding Qualities of Aspen Wood

Aspen wood is not durable. It cannot be expected to last more than three or four years, and may decay considerably in one year, when used in places where the moisture content of the wood will remain comparatively high. The danger points in buildings are: (1) sills, (2) joists and subfloors in buildings without a basement and where the ventilation is poor, (3) interiors of poorly ventilated barns and other farm buildings, (4) steps and porch columns, and (5) posts resting on the ground or on concrete or embedded in concrete. Aspen wood used in such places should be treated with a wood preservative in order to prolong its service life.

Aspen wood, along with basswood and cottonwood, stands at the top of the list of hardwoods in paint-holding ability. This is one reason why aspen wood has been used for interior finish, especially in places where it is to be painted. The wood also takes a good natural finish and such figure as the wood possesses shows up fairly well. Ordinary house paint, when applied to aspen wood for exterior use, should last four years before repainting becomes necessary (See figure 2). Good quality iron-oxide paint will last about six to seven years.

3/ See Lake States Aspen Report No. 7 for a more detailed discussion.

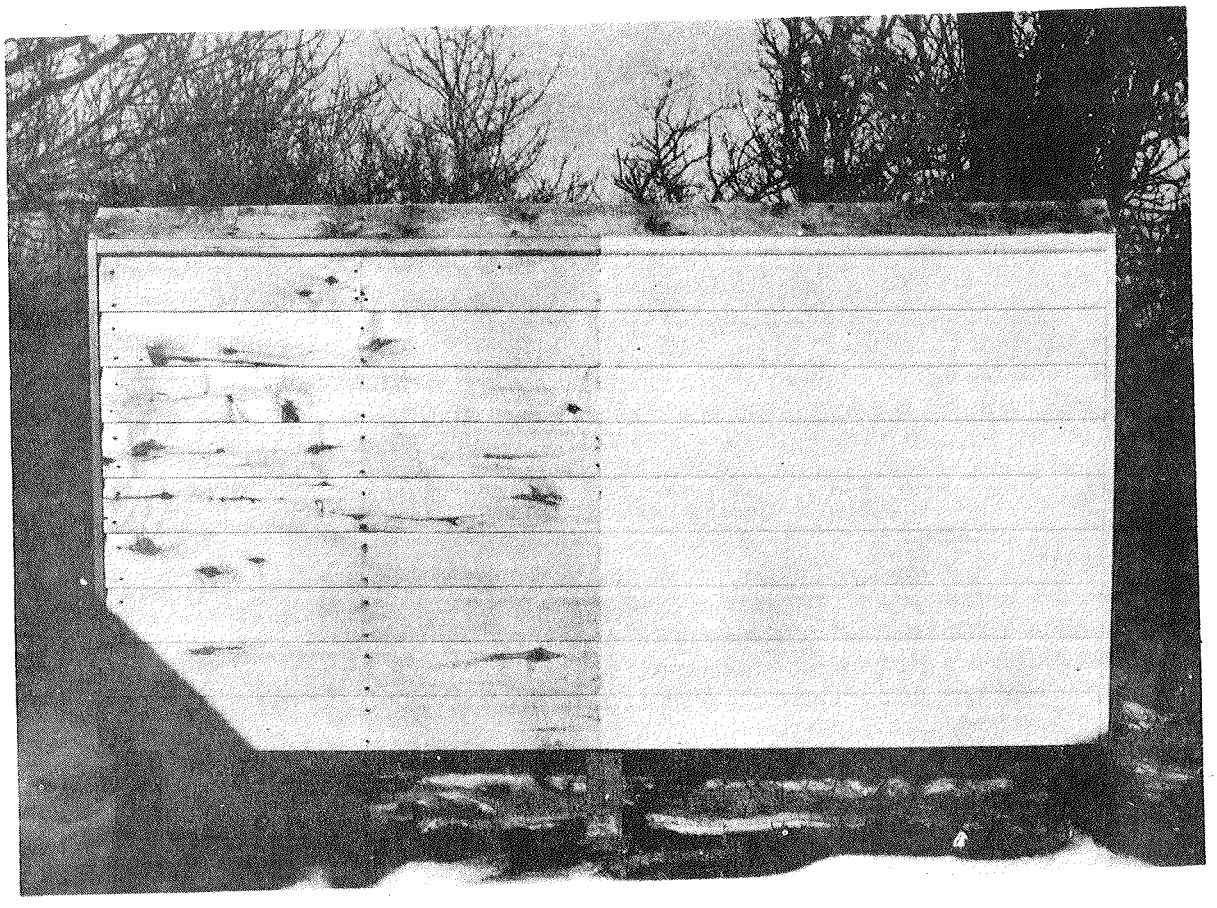

Figure 2.--Aspen drop siding panel after covering one-half of panel with three coats of white lead paint. Note that all knots covered well. After two years' service, the paint surface was still in excellent condition.

Planing Properties of Aspen

Aspen, like most other woods, planes best at a moisture content of about 6 per cent based on the over-dry weight of the wood. The drop siding panel shown in figure 2, however, was surfaced at a moisture content of about 15 per cent, and it was smooth enough to present a good surface for painting. In some of the pieces, not evident in the photograph, there was a slight amount of furring. Another defect which may develop in aspen lumber during planing is chipped grain. Chipped grain and furring generally occur in the irregular grain in the vicinity of knots. These defects can be overcome sufficiently for building purposes if the lumber is thoroughly air seasoned and the planer knives are kept sharp and placed at the correct angle.

Sizes of Aspen Lumber Produced

The main objection to the use of aspen lumber for building purposes is that the boards are narrow, variable in width, and generally short. Most aspen logs have been cut in 100-inch lengths. At most mills, however, aspen lumber of greater length can easily be produced when such is desired.

A study made at a box factory mill located in northern Minnesota showed the number of boards and the amount of lumber produced from 2,940 (100 inch) aspen logs ranging in diameter from 5 inches to 15 inches at the small end. Although boards from 3 to 14 inches in width were produced, the greater part of them were between 4 and 7 inches (table 1).

Table 1.--The amount of aspen lumber produced in boards of various widths from 2,940 (100-inch) aspen logs

Width of boards	Number of boards	Lumber scale	Per cent of total
Inches		Board feet	
3	1,558	3,195	4.8
4	2,558	6,807	10.3
5	3,706	12,264	18.5
6	3,059	12,425	18.8
7	2,144	10,150	15.3
8	1,516	9,296	14.1
9	905	5,619	8.5
10	478	3,266	4.9
11	218	1,662	2.5
12	119	1,006	1.5
13	51	455	.7
14	3	28	.1
Total		66,173	100.0

About one-third of the total lumber scale was produced in boards 5 inches or less in width. The remaining two-thirds of the total scale was in boards 6 inches or over in width. Although they have their limitations, narrow boards can be used for building purposes. Boards 4 inches wide are often made into flooring while boards 6 or 8 inches wide can be made into shiplap, drop siding, or bevel siding. Care in sawing and increasing the size of the smallest log would largely eliminate material less than 4 inches in width. It would be desirable to cut only lumber from logs which are at least 8 inches in diameter at the small end.

Quality or Grade of Aspen Lumber Produced

Aspen lumber for building purposes usually is not graded. To obtain information on the approximate grade distribution of aspen lumber, the boards listed in table 1 were graded according to hardwood grading rules

for construction lumber. About 4.5 percent of the total lumber scale graded as A and B finish. About 13 percent of the total scale graded as No. 1 construction boards; 32 percent as No. 2 construction boards; and 45 percent as No. 3 construction boards. The remaining 5.5 percent contained considerable decay and were considered as unfit for building purposes. At another mill, also located in northern Minnesota, aspen logs were cut mostly into 8/4 inch dimension stock. The dimension stock obtained from 321 aspen logs graded approximately 33.5 percent No. 1 dimension and 61.5 percent No. 2 dimension. The remaining 5 percent were discarded because of the presence of decay. Ninety-five percent of the logs from which this stock was produced were between 5 inches and 9 inches in diameter at the small end. All the logs were 100 inches long. The material was cut in widths of 4, 6, and 8 inches.

PRESENT USE OF ASPEN LUMBER FOR CONSTRUCTION

In 1945, about 15,000,000 board feet of aspen lumber were used in the Lake States for building construction--most of it in rural areas. Such use has developed almost entirely during the past decade.

Most of the aspen lumber used for building construction is cut locally, often from the owner's woodland. Generally it is seasoned and then hauled to a local planing mill for further processing where that is feasible. It is often found in lumber yards in the northern part of Minnesota, especially in those which are operated in conjunction with a combined sawmill and planing mill. Most of this material is in the form of flooring, shiplap, or dimension. However, at least one Minnesota mill will manufacture aspen into any desired building product.

Aspen lumber is rarely handled by independent lumber yards outside of the commercial range of the species. One of the main reasons is that the boards are relatively narrow and short, which increases the cost of handling, especially in building construction. Another objection is that the price is generally too high to compete with the lower grades of pine which are widely used for building purposes. Apparently there would be considerable demand for the higher grades if these could be obtained in sufficient quantities.

During the survey made in northern Minnesota in 1944 about 25 buildings were examined in which at least some aspen had been used. Thirteen of these buildings were dairy barns. However, aspen lumber was also being used in construction of other farm buildings such as chicken houses, granaries, machine sheds and garages. It was also used in residence construction in both rural and urban areas. Several cases were also noted where aspen logs were used in the construction of log houses and cabins.

Usually aspen lumber is not selected for any particular use. Commonly it is mixed with other structural woods growing in the region and used for all building purposes, provided the pieces are large enough to fit the requirement. It has been used satisfactorily for sills, girders,

girder posts, joist, studding, rafters, sheathing and roof boards, subfloors, flooring of various types, interior finish and often in the form of drop siding or bevel siding for exterior finish. In some cases, it is also used for shingles. A dairy barn, located near Bagley, Minnesota, built in 1944, was constructed entirely of aspen, even to the shingles. Another dairy barn (see figure 3) which was built in 1942 near Waubon, Minnesota, used the following material (almost all local wood):

1. Sill - northern bur oak
2. Girder posts - aspen
3. Girders - aspen and northern bur oak
4. Girder caps - northern bur oak
5. Joist - aspen and some northern bur oak
6. Mow floor - aspen - 6-inch flooring
7. Studding - aspen
8. Plate - northern bur oak
9. Rafters - (bent type) aspen
10. Sheathing and roof boards - aspen
11. Exterior finish - basswood bevel siding
12. Shingles - western red cedar
13. Window frames - aspen
14. Stanchions, stalls, and mangers - aspen

It is not intended that this list should indicate the wood best suited for a given purpose. It is merely an outline of the different woods used in construction of this particular barn. However, the barn is well constructed. The foundation is about 8 inches above the floor on the inside The girder posts are set on a cement base projecting about 6 inches above the cement floor level. A durable wood was used for the sill and the inside of the barn is well ventilated. Many other cases could be cited with minor variations from the outline given above.

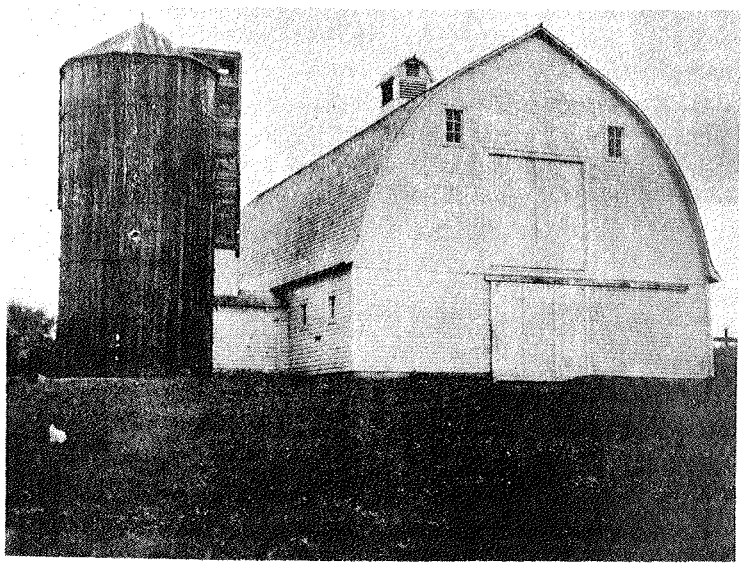

Figure 3.--Dairy barn constructed in 1942 using about 90 percent aspen lumber.

RECOMMENDATIONS FOR THE UTILIZATION OF ASPEN LUMBER FOR BUILDING CONSTRUCTION

Aspen lumber has been used for the construction of an entire building. However, the inherent qualities of the wood make it more suitable for some uses than for others. An understanding of these qualities and how to use or treat the wood will aid in obtaining more satisfactory results.

Since aspen wood is not durable, it should not be used without preservative treatment in places where it is subject to decay. In most buildings the sill is most subject to decay. The sill is also one of the most vital spots in building construction. Either a durable wood, such as the heartwood of white oak, northern bur oak, or northern white cedar, should be chosen, or else the nondurable wood should be given careful treatment with a good wood preservative.

Aspen lumber is best suited for sheathing, roof boards, and subflooring. No. 3 construction boards can be used for these purposes. The lumber can be used in the rough, to decrease building costs, surfaced on one or both sides and one or both edges, or in the form of shiplap. Surfacing at least on one side and on one edge is desirable as it makes a smoother surface for the application of the exterior layers and allows boards of uniform width to be placed in a given sheathing course. Shiplap makes a tighter form of construction and can be made in different widths. If they are cut about 7/8 inch in thickness, boards to be used in the rough will approach the standard thickness of yard lumber after it has been air seasoned. It is important that lumber used in the rough should be accurately sawed as to thickness and width. Inaccuracy in sawing is one of the commonest objections to the use of rough home-sawn lumber for building construction.

Since aspen wood is not strong and often contains defects, it must be used with a certain amount of caution for framing materials such as studding, joists, and rafters. For small buildings such as chicken houses, garages, granaries, and small houses, aspen 2 x 4's are strong enough for studding and in many cases for rafters, especially where the rafter is short. In large buildings such as dairy barns, the studding should be made of 2 x 6's and the joist, not over 12 feet long, of 2 x 8's or larger. The joists in the barn shown in figure 3 are mostly aspen 2 x 8's. However, a few joists of the same size are made of northern bur oak.

There are a number of ways of increasing the strength of joists. A joist which is full 2 x 10 in size is 36 per cent stronger than one surfaced to standard size of 1 5/8 x 9 1/2. Doubling the width or doubling the number of joists would double the strength, while to increase the depth from 8 inches to 10 inches would increase the amount of wood by 25 per cent, and increase the strength about 56 per cent. Carefully sawed joists can be used in the rough. For ease in construction, however, it is better to have the joists surfaced on the edges in order that they may be uniform in depth.

In many instances, aspen 2 x 6's have proved satisfactory for rafters in gambrel roof barns where the longest rafter was not over 14 feet. Most dairy barns are built with the gothic roof, using either sawed or bent-type nailed rafters. Either type made of aspen has proved satisfactory where sufficient laminations of material have been incorporated into the rafter. Six layers of 1 x 4 aspen boards appear to be about the minimum for the construction of substantial bent nailed rafter. Such a rafter placed 2 feet on center was used in constructing the barn shown in figure 3. One case is known where gothic rafters were constructed with 4 layers of 1 x 4 aspen boards. Every fourth rafter was well braced on the inside. That such bracing was insufficient and, further, that the rafters were not well designed are indicated by the fact that the unbraced rafters have settled considerably, giving the roof a sway-back effect.

Because of its painting qualities, aspen lumber has been used for some time as interior finish. In some cases it has been used for interior paneling and finished in natural color. It is often used in the form of shiplap or at least finished on one surface for interior finish of barns, garages, and other farm buildings. A garage near Greaney, Minnesota, was lined with aspen shiplap in 1929. It was still in good condition in 1944 after 15 years of service. A dairy barn near Aitkin, Minnesota, built in 1942, is similarly lined.

Aspen wood is often used for exterior finish. It is sometimes used in the rough for this purpose. Rough aspen lumber used on the exterior of a warehouse located near Greaney, Minnesota, was in good condition in 1944 after 19 years of service. Similar material used on the lower part of a barn located near Fertile, Minnesota, was also in good condition after 22 years of service. In both cases the saw marks are still present on the surface of the boards. There are numerous cases where aspen drop siding has been used. It is also made into bevel siding. When aspen lumber is made into siding, it is probably best to make some selection of the better material, such as No. 2 construction boards or better. Most defects in this lumber will cover well with paint (see figure 2).

It is important that good construction practice be followed in applying any siding. Bevel siding is lapped 3/4 inch for 3-inch siding, 1 inch for 6-inch siding, and 1 1/2 inch for siding over 6 inches. This lap is sufficiently great so that a nail will go through the bottom portion of one piece and through the top of the piece beneath. Failure to provide enough overlap is illustrated in figure 1, where most of the nails missed the top edge of the boards entirely.

That aspen lumber can be used for flooring has been amply demonstrated. The mow floor in the barn shown in figure 3 was made of 6-inch aspen flooring. A planing mill at Bagley, Minnesota, was floored with 2-inch rough aspen planks. An aspen store floor in a northern Minnesota town was laid in 1908 and was still in use after 34 years of service. Properly seasoned aspen flooring appears to wear smoothly.

Very little is known regarding the use of aspen shingles. A small barn built near Swatara, Minnesota, in 1938, was covered with aspen shingles. The roof was still in good condition in 1944. Another barn, built in 1944, was covered with aspen shingles. The owner, basing his statement on previous experience, said that he expected these shingles to last at least 15 years. It should be possible to treat aspen shingles with a wood preservative which would probably double their service life. On roofs with considerable pitch, untreated aspen shingles may perform reasonably well, but they should never be used on low pitch roofs unless first treated with a wood preservative.

SUMMARY

Aspen lumber can be used successfully for building purposes, as has been illustrated by several examples, if the inherent qualities of the wood are used to best advantage and good construction practices are followed. To summarize the previous discussion and to emphasize precautions to be observed in good building practice, the following points should be followed: (1) Build on a well-drained site; (2) use lumber that has been thoroughly air seasoned for framing, sheathing, etc., and kiln-dried lumber for interior finish of homes; (3) use a naturally durable heartwood or treat aspen lumber with a good wood preservative if it is to be used for sills or in other places where it is subject to decay; (4) extend foundation walls at least one foot above the ground to keep the wood away from ground moisture; (5) provide for adequate ventilation in barns and beneath floors where there is no basement; (6) see that insulation materials are properly used; (7) make tight construction joints and use drip caps over doors and windows.

BIBLIOGRAPHY

(1) Bell, L. E. and Jefferson, C. H.
1944. Use of Jack Pine and Popple for Farm Buildings. Mich. State College Ext. Bul. 255, 23 pp., illus.

(2) Betts, H. S.
1944. American Woods--Aspen. Forest Service, U. S. Dept. Agr., Washington, D. C.

(3) Browne, F. L.
1942. Painting Hardwoods in Farm Buildings. Forest Products Laboratory Mimeo. 1291, U. S. Dept. Agr.

(4) Christopherson, C. H. and Rees, L. W.
1945. Home Grown Timber for Farm Buildings. Minn. Farm and Home Science, Vol. II, No. 2, illus.

(5) Cunningham, R. N.
1946. Revised Forest Statistics for the Lake States. Lake States Forest Experiment Station Paper No. 1, illus.

(6) Forest Products Laboratory
1938. Nail Holding Power of American Woods. Forest Products Laboratory Tech. Note No. 236, U. S. Dept. Agr.

(7) Forest Products Laboratory
1940. Methods of Applying Wood Preservatives. Forest Products Laboratory Mimeo. R154, U. S. Dept. Agr.

(8) Johnson, R. P. A., Kittredge, J., and Schmitz, H.
1930. Aspen--Availability, Properties, and Utilization. Univ. of Minn. Agr. Expt. Sta. Tech. Bul. No. 70, 72 pp., illus.

(9) National Hardwood Lumber Association
1944. Rules for the Measurement and Inspection of Hardwood Lumber, Cypress, Veneers and Thin Lumber. Nat. Hardwood Lbr. Asso. Chicago

(10) Schwantes, A. J., and White, H. B.
1945. Farm Building Priorities for the Postwar Period. Minn. Farm and Home Science, Vol. III, No. 1

(11) Sweet, C. V., and Johnson, R. P. A.
1936. Selection of Lumber for Farm and Home Building. U. S. Dept. Agr. Farmers Bul. No. 1756. 45 pp., illus.

(12) White, C. H.
1942. Home Grown Timber for Farm Buildings. Univ. of Minn. Agr. Ext. Bul. 238, 16 pp., illus.

(13) Zasada, Zigmond, and Kluender, W. A.
1946. The Future of Aspen in the Lake States. Chemurgic Digest, Vol. V, No. 11.

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