LAKE STATES ASPEN REPORT NO. 3

LOGGING METHODS AND PEELING OF ASPEN

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JULY 1948

PROCESSED BY
U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
LAKE STATES FOREST EXPERIMENT STATION

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.

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LOGGING METHODS AND PEELING OF ASPEN[1/]

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The logging of forest products is influenced by many factors, including the size of the trees, density of the stand, the soundness of the trees, size of the area logged, topography and soil, weather conditions, the degree of utilization, the skill of the logger and the equipment used, the distance from market, etc. Each of these factors influences not only the method of logging but also the costs. The purpose of this paper is not to cover in detail the effect of each of these variations, but to deal with some of the major problems typical to logging aspen. Well-known practices common to all logging operations will be mentioned only briefly.

GENERAL TYPE AND CONDITION OF ASPEN STANDS

No definite figures are available on the variations in stand density and tree size on different quality sites as they exist in the forest Most of the data available give figures for stands of good, medium, and poor density without regard to site. Often the density of the stand is correlated with the site quality. Aspen stands do vary a great deal throughout the region. Chase (2)2/ states that for the Lake States region as a whole 15 percent of the aspen is growing on good sites, 54 percent on medium-quality sites, and 31 percent on poor sites. Normal yield tables (1) indicate a considerable variation in stands on different sites Thus at 50 years of age a normal aspen stand growing on a good site will have from 400 to 495 trees per acre with an average d.b.h. of from 7 to 8.1 inches and a merchantable volume varying from 55 to 63 cords per acre Stands on medium sites at 50 years will have from 495 to 645 trees per acre with an average d.b.h. varying from 5.9 to 7 inches and a merchantable volume varying from 44 to 63 cords per acre. Aspen stands on poor sites will, at 50 years, have from 645 to 856 trees per acre with an average diameter from 4.6 to 5.9 inches and a merchantable volume from 26 to 44 cords. Variations such as these have a marked influence on logging costs.

These normal densities and volumes are seldom found over extensive areas, as is indicated in the report on forest conditions in Carlton County (5), where 40-year-old aspen stands were found to have an average volume of 18 cords per acre and a current annual growth rate of .56 cords. These

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1/ Published as University of Minnesota Agricultural Experiment Station Misc. Journal Series No. 632.
2/ Underscored numbers in parentheses refer to literature cited.

stands would average 23.6 cords per acre at 50 years, which is considerably less than shown in the normal yield table but still large enough to be attractive to loggers.

Since most aspen stands have become established as the result of fires following logging, they are found on all types of soils and topography from level swamps to rugged morainic formations. In Minnesota the best stands are found on islands in swamp areas and on lake-washed, till-clay formations. These areas are relatively level except where past glacial streams have cut deep valleys, as is the case in the southeastern portion of Carlton County. In general, the aspen stands of the Lake States occur on terrain which does not present any difficult or peculiar logging problems different from those of other species in the area.

The fourth factor which influences both logging methods and costs is defect or cull. It is relatively easy to recognize very defective stands by the presence of fruiting bodies of the fungus, Fomes ignarius, the rough bark of the stem, the flat top of the crown, and the unthrifty crooked branch development. Sound stands are easily recognized by the smooth bark, often whitish in color, the pointed crown, and the thrifty straight branches. In between these two extremes are found stands with varying degrees of defect often difficult to detect and evaluate in advance of cutting. The type of utilization influences to a great extent the effect of the defect, especially in the case of heart rot. Utilization of aspen for box boards and lumber is affected most by the presence of heart rot. In a normal market even the discoloration of incipient rot is undesirable in these products. Bolts for match splints are probably affected by the occurrence of heart rot to almost as great an extent. In this case, however, the location and extent of the rot or discoloration are important. For example, a match splint bolt with an area of rot 4 inches in diameter located in the center of the bolt and sound enough to hold the lathe chuck would not be considered defective. Some discoloration and incipient rot are tolerated in aspen pulpwood bolts The tolerance is greater when the bolts are used for wallboard than for paper.

Studies made by Schmitz and Jackson (8) showed that rot occurred in stands of all ages from 10 years of age up. After the stands passed 50 years of age, the rot became a serious factor, often reducing the merchantable volume of trees as much as 35 percent in older stands

The presence of rot has little influence on methods of logging, but it does influence the cost since it reduces the merchantable volume The detection of rot and its evaluation are difficult and at least at present must be based on practical experience.

One other form of cull which is easily detected is that due to canker, Hypoxylon pruinatum. Since this parasite is external and usually results in a dead or partially dead tree, its effect and extent are easily judged.

PRESENT LOGGING METHODS

Methods of logging aspen follow, in general, the normal procedure of logging other species in the region, whether it be for sawlog stands or pulpwood stands by large or small operators. Large operators are, of course, organized on a different basis than small operators.

The common practice is to fell the trees, swamp them, and buck them into the required lengths. The bolts, which are usually 100 inches in length, are then bunched in irregular piles along a skid road for subsequent skidding to the landing. Where piece cutters are employed, the operator marks out strips for each cutter or pair of cutters. The width of these strips will vary with the density of the stand and the average size of the individual tree. The denser the stand and the larger the trees, the narrower the individual cutter's strip. The minimum width is usually slightly more than the height of the trees, making it possible for the piece cutter to fell all his trees on the area assigned to him. Piece cutters are required to cut skid roads and pile the bolts in measurable piles.

A great deal of interest is being displayed in new equipment developed to make labor more efficient in logging. Most of this equipment is still more or less in the experimental stage and is not in general use. Much of it is quite expensive and requires a large operation to justify the investment. Since a large percentage of the aspen cut is produced by small operators and farmers, the old equipment and methods are in common use.

Mobile pulpwood harvesters are being tried experimentally in many places. Machines such as the Montague, Allen, Sonoco, and Davis seem to have many desirable features. These machines are either tractor- or trailer-mounted and bring the tree bole to the cut-off saw by means of live rolls or conveyor chains. The bolts are conveyed to waiting trucks by conveyor chains. Production figures from 35 to 60 cords per day using 2 to 4 men on the machine are claimed. The machines work better with pine than with the more crooked aspen boles. Where pulpwood harvesters are used, some form of arch or winch for tractor skidding is desirable but not essential. Horse skidding or ground skidding with tractors is satisfactory, but more of them are required on hot logging operations. However, a single horse can skid to cold decks in advance.

Portable power saws are being used quite commonly. Chain saws seem to be much preferred over the circular saw, although the "Sally Saw," which uses a circular saw driven by cogs engaging in holes of the rim, is apparently quite efficient. The circular power saw mounted on bicycle wheels commonly used in the south for felling and bucking is not suitable for felling and bucking aspen stands of the Lake States because of brush, rough topography, and deep snow in the winter. Very often it is difficult to transport the power saws from tree to tree in brushy stands. The shorter felling time is more than offset by greater travel time. Under such circumstances the trees are usually felled with a cross-cut saw and brought to a landing full length for bucking with a power saw.

One of the big problems in utilizing aspen is the poor quality of "off site" stands. Stands of this type need efficient logging and utilization since the quality of product is low and the volume per acre is small. Stands of this type usually begin to deteriorate at an early age, often when the average diameter is not more than 5 inches. In many sections stands such as these are not merchantable even with efficient logging, since no industry utilizing this class of material is at hand. Where a market for such products does exist, these poor quality stands can be cut at a profit, as was shown by a study made at the Forest Experiment Station at Cloquet during the winter of 1941-42 (6).

A 25-year-old stand of "off site" aspen which had begun to deteriorate, due to canker and rot, was clear-cut for pulpwood or conversion wood The stand yielded 11.8 cords per acre Cutting was done by contract at $2.50 a cord. Skidding cost was $0 50 a cord and hauling to the mill $1 a cord, making a total cost of $4 per cord The wood brought $5.50 a cord, leaving a profit of $1 50 a cord. The profit was not large, but from the standpoint of the small owner who could invest his own labor, it was still attractive.

In order to determine whether or not the use of power saws would help reduce the cost of logging small "off site" aspen, a logging time study was carried out in such a stand at the Cloquet Experimental Forest during the spring of 1946 (7). One portion of the stand was logged by one-man crews using bow saws and axes. The bolts were piled along skid roads for skidding with a dray. A second portion was logged by a two-man crew using a cross-cut saw for felling and a bow saw for bucking Here again the bolts were piled along a skid road for dray skidding. The third and fourth portions of the stand were felled by these two crews as before, but the trees were swamped and left full-length for later skidding to the landing. At the landing the tree boles were bucked into pulpwood lengths, using a circular power saw and a 14-inch chain saw. The following table gives the man-hours needed to produce a cord of 100-inch pulpwood at the landing by the various methods:

Table 1.--Man-hours to produce a cord of 100-inch pulpwood by various methods

Methods	Man-hours per cord
2-man crew with dray skidding	5 29
1-man crew with dray skidding	4 05
1-man crew felling, full-length skidding, circular power-saw bucking	8.05
2-man crew felling, full-length skidding, chain-saw bucking	8.41

This preliminary study indicates that hand tools are apparently more efficient than power saws in the production of pulpwood in stands of

small average diameter. In this stand the average d.b.h. varied from 4.6 to 5.2 inches, while the per-acre volume amounted to 13.5 cords. Tree lengths were skidded by the tractor on the ground, and this reduced the volume per trip to .15 cord and caused considerable time loss by the landing crew. Possibly a change in skidding method might increase the volume per trip and eliminate the lost time of the landing crew. While this study is not conclusive, it indicates the need for planning and organization when mechanical equipment is used.

Very few time studies have been made on aspen logging operations. One such study was made by Zehngraff (12) in a 50-year-old stand on a good site on the Chippewa National Forest in 1945. All cutting was done with one-man crews using Swedish bow saws. These saws proved more efficient for felling and bucking trees under 9 inches in diameter than for larger trees.

The following table summarizes the results of this study:

Table 2.--Cutting and skidding time

(By 100-inch pulpwood bolts)

Diameter of bolts	No. bolts per cord	Total time: Felling, trimming, bucking				Skidding (by dray) Avg. distance 232 ft			
		No. bolts per hour	Time per cord	Time 1/ per MBM		No. bolts per hour	Time per cord	Time 1/ per MBM	
			Hrs.	Min.	Hrs. Min.		Hrs	Min	Hrs. Min
4	89	36	2	30	.. ..	54	1	33	.. ..
5	60	33	1	48	.. ..	36	1	40	
6	43	29	1	28	6 50	26	1	37	7 33
7	33	25	1	20	4 02	21	1	32	4 40
8	26	20	1	17	4 55	18	1	27	5 30
9	22	16	1	20	3 06	16	1	24	3 10
10	18	13	1	23	2 32	14	1	17	2 22
11	15	10	1	26	3 11	13	1	10	2 36
12	13	8	1	34	3 01	12	1	06	2 07
13	11	6½	1	44	3 01	11	1	03	1 49

1/ The somewhat uneven time per MBM is because the Scribner scale rule is erratic when applied to small bolts.

Cutting and skidding time
(By tree diameter)

D.B.H. class	Per cord		Per M	
	Hrs.	Min.	Hrs.	Min.
5	3	50	.	..
6	3	21		
7	3	07	17	44
8	3	03	14	38
9	2	56	11	38
10	2	54	9	48
11	2	51	8	23
12	2	51	7	39
13	2	48	7	02
14	2	50	6	31

The figures in table 2 indicate that felling, trimming, and bucking time per cord or per M board feet decreases with increase in size of bolt up to about 8 inches, after which there is a gradual increase. This can be attributed to a lower efficiency of the bow saw on the larger sized trees. When the data are arranged according to tree diameters, the cutting and skidding time decreases with increased diameter of tree.

Table 3 from the same report (12) by Zehngraff gives the skidding time by distance for both dray and chain skidding:

Table 3.--Skidding time by distances (by 100-inch bolts)

Distance	Ground skidding				Skidding by dray 1/			
	Time per bolt	No. bolts per hour 2/	Time per cord 3/		Time per bolt	No. bolts per hour 2/	Time per cord 3/	
Feet	Seconds		Hrs.	Min.	Seconds		Hrs.	Min.
50	127	28.3	1	10	153	23.5	1	24
75	150	24.0	1	22	154	23.2	1	25
100	166	21.7	1	31	155	23.2	1	25
125	179	20.1	1	38	156	23.1	1	26
150	189	19.0	1	44	157	22.9	1	26
175	198	18.2	1	49	159	22.6	1	27
200	207	17.4	1	54	161	22.3	1	28
225	215	16.7	1	58	163	22.1	1	29
250	222	16.2	2	02	165	21.8	1	31
275	229	15.7	2	06	168	21.4	1	32
300	236	15.2	2	10	171	21.0	1	34

1/ All dray skidding is based on one man (twice the time recorded for 2 men).
2/ Average size of bolts = 7.05 inches.
3/ Average number bolts per cord = 33.

The data show that dray skidding was cheaper for distances over 80 feet. The increase in distance has much less influence on the cost of dray skidding than when chains are used. It takes an hour longer to skid a cord by chain 300 feet than 50 feet, whereas the increased time in dray skidding for 300 feet over 50 feet amounts to only 10 minutes.

LOADING AND TRUCKING

Water transportation of aspen is not important in this region. Practically all the wood is delivered by truck or rail.

Aspen is a relatively heavy wood when green. The Wood Handbook (11) gives the weight as 43 pounds per cubic foot green and 26 pounds per cubic foot dry. The green weight may vary as much as 20 percent depending upon the age of the tree and the site. The common weight used by the industry is 5,000 pounds per cord green with bark and 3,000 pounds peeled and partially dry. One firm has recently begun purchasing aspen pulpwood by weight, using 4,800 pounds per cord for wood 4 inches and over in size and 4,300 pounds per cord for wood 3 inches and larger. This puts a premium on the delivery of green wood the company needs.

Much aspen is transported by trucks either to the railhead or direct to the mill. Its weight makes hand loading difficult. If we accept the weight of 4,800 pounds per cord green as correct, 12-inch bolts would weigh 369 pounds each, and 8-inch bolts 186 pounds each. When these bolts are boosted to the top of a load, it is heavy work. On some jobs the conventional homemade jammer is used. Many loggers are beginning to develop swing-boom jammers mounted on their trucks. End-loading trucks using a winch located either on the front bumper or directly behind the cab are also used. However, most pulpwood is still being loaded by hand. Mechanical loading equipment should become more common in these times of high wages.

SEASONING

Whether or not aspen bolts and logs should be seasoned depends on their utilization. If the end product is lumber, a moderate amount of seasoning in the logs is beneficial. It can, however, be carried too far and cause some loss. If the pulpwood is going into sulfite pulp, it should be seasoned to avoid difficulties which may arise from gum spots in the pulp. Rough aspen is often held in the yard for a year. This makes bark removal much easier as well as seasoning the wood. Green wood is preferred for mechanical pulp and for kraft, where the wood is used as soon as possible after delivery. Since logging, even in aspen, is more or less of a seasonal job, it is impossible to have the supply coming in at the desired rate the year around, so some storage is necessary. To avoid excessive decay loss, rough wood should be used by the second summer following cutting. A minimum of 20 percent of green wood is used to obtain the desired strength in ground-wood pulp for wallboard. It is the opinion of the industry that winter-cut wood is not as subject to decay as summer-cut wood. This may be due in part to seasoning which winter-cut wood undergoes during the period of the year when decay does not develop rapidly.

If aspen is to be used for match splints, it should be green in order to veneer properly. Aspen for this use cannot be held over and should be used by the August following cutting. Since it is desirable to hold back seasoning, bark is an asset. The B. F. D. Company at Cloquet

has recently tried tree-length logging of aspen in its operations in northern St. Louis County. During the 1946-47 season, one-third of its production was handled this way. Trees were felled and limbed, skidded with arches on caterpillar tractors, loaded by means of a specially built side-jammer powered with a jeep engine, and hauled by truck to the shipping yard at the railhead. The trees were left full length until summer when they were bucked into the desired lengths with a power saw and shipped to the plant. In general, the bolts were green except for the stick from the top and a moderate amount of seasoning in the butt section.

No special precautions were noted in the yards either to promote or retard seasoning. High piles seem to be preferred, and an effort is made to provide ample space between the piles.

USE OF MECHANIZED EQUIPMENT

The most difficult problem in logging aspen at present is the amount of handwork required. Its relatively heavy green weight makes this difficult. Some of this will be overcome when mechanical loading equipment and mobile pulpwood machines come into common usage The problem will, however, still remain when piecework is done. Here there is the problem of bunching bolts along a skid road. Often the width of the strips is influenced by the distance cutters have to move heavy sticks of pulpwood This work can be made easier by the use of hand-cant hooks, log tongs, and similar devices for handling bolts.

On large jobs and where the trees are of sufficient size, "long-logging" seems to hold some promise. Tree lengths can be concentrated at a yard and cut into lengths either with a power saw or mobile pulpwood harvester. Very often better utilization results from this method since it is possible to see the entire bole of the tree as a unit and, in cutting it up, take into consideration crooks and other defects

BARKING AND PEELING

Peeling or barking is essential when aspen is to be used for most high-quality papers and pulps. If this can be done in the woods, the seasoning of the wood can be started earlier and a considerable saving in shipping costs will result because of the reduced weight. When the wood is to be used for wallboard or veneer, peeling in the woods is not desirable.

At present the common method is hand-peeling, using a spud. This can be done efficiently only during the peeling season, which normally extends from May 15 to July 15 During this period tne cambium is active and the bark slips easily. Vegetative activity will take place at this time in bolts cut during the fall and winter. If logging is in progress on any job during the peeling season, the trees are felled and limbed and peeled immediately. Bucking into bolts is delayed until the peeling season is over.

Mechanical barkers and peelers are being developed for use in the woods and at the plants. These machines operate more efficiently during the peeling season.

Most pulp mills remove the bark of aspen in the conventional drum barker. When rough aspen has been seasoned for a year or more, this method is quite efficient, although a large proportion of the bolts must be returned for a second trip through the barker. The drum barker is not efficient for green wood. Complete bark removal is essential for making high-quality paper.

When aspen is used for wallboard, the bark is usually included with the wood. Although bark is not an asset in the manufacture of wallboard, it is tolerated. If the bark could be removed efficiently and economically, a somewhat better grade of wallboard could be produced. Since the difference is not great, it might be necessary to develop some use for the bark to help carry the cost of the operation. Wood used for wallboard must be green, so barking is often difficult. Wallboard manufacturers are interested in barking machines which will handle green wood, and particularly frozen green wood. Some experimental work has been done in the development of such machines.

One of the newer developments in barking machines is the Allis Chalmers "Stream Barker." In this machine, water under pressure of 650 pounds for unfrozen wood to 750 pounds for frozen wood is forced against the stick as it is rotated over two parallel rollers revolving at different speeds. One roller is fluted, and one is spirally threaded. The manufacturers claim that this machine eliminates the need for rossers, reduces the need for knot borers, and results in considerable saving of wood. They admit that aspen bolts are more or less battered at the ends because of the normal crook in the bolts. One manufacturer voiced the objection that only one stick could be barked at a time and that to supply his mill a large battery of such barkers would be needed.

Various other types of barkers are being developed and tried throughout the region. Most of these are hammer barkers or a combination of hammers and knives, and usually some hand-cleaning of the wood is required after passing through the machine. Hammer barkers have the disadvantage of pounding the bark into the wood and breaking some of the fibers. Most of the present barking machines operate more efficiently on green wood during the normal peeling season.

One of the big problems in machine barking has been to remove the bark without excess loss of wood. The loss of even a small percentage of wood can become costly where a large volume of pulpwood is consumed. However, if the cost of hand-cleaning exceeds the value of wood loss, it may be more economical to stand the loss in barking.

The increased production of fence posts in the South and elsewhere has brought about the development of barking and peeling machines for use in the woods. Most of these machines are adaptable to pulpwood. They are described in a bulletin issued by the Louisiana Forestry Commission (4) and in reports of the Forest Products Research Society (9).

These machines are of three types: friction machines, hammer machines, and lathe or knife machines having either stationary or floating cutterheads.

Friction machines depend on the action of the posts rubbing against each other to remove the bark as in dry drum barkers. They work on much the same principle as the drum barker. Most of these machines have been constructed by the operator. They consist of a drum, in which the bolts or sticks are placed, and an engine varying from 5 to 20 horsepower, depending on the size of the drum. Two men are required to operate the machine, and the usual capacity is from 900 to 1,600 posts or bolts per day. The machine is not efficient for hardwood species during the winter and produces best results on all species during the normal peeling season.

The hammer machines depend on the pounding action of chains or hammers against the bolt to remove the bark. Both the Click and the Lowther Post Peelers use a spool and chain assembly which, when rotated, causes the chains to strike the sticks and thus remove the bark. Considerable skill is needed to feed the sticks and rote them properly, which must be done by hand. Production varies from 300 to 400 sticks per day and is limited by the weight of sticks handled. It can be used on hardwoods efficiently only during the spring and summer.

Peeling machines such as the lathe type barkers and those with floating cutterheads are not efficient for pulpwood as much wood is lost. The Peppy Peeler developed in Ontario is a small portable machine powered by a 6 horsepower gasoline engine. The stick is fed and turned over a set of revolving blades. Less than thirty seconds is required for peeling a stick. The manufacturer claims that any species can be peeled at any season of the year. A rough check of a specimen of the bark removed showed that about one-third of the material removed was wood fiber.

During the past few years a chemical treatment of live trees has been developed in Canada which is reported to loosen the bark and hasten seasoning (10). The tree is girdled with two saw cuts 2 inches apart and the intervening bark removed. A specially built saw is used to make the cuts simultaneously. Ammonium sulfamate and other chemicals, including arsenic compounds, are applied in paste form on the girdled portion and held in place with a cloth bandage. The chemical begins to take effect in about four days, and it is claimed that the tree dies within a month after treatment. The bark is reported to be easily removed after cutting without the use of special equipment, and the wood is said to show a 28-percent water loss.

Since Ammonium sulfamate (Ammate) is a herbicide which is easily translocated and is recommended for use on cut surfaces to prevent sprouting, it is possible that its use on aspen would impair the species' ability to reproduce by means of root suckers.

Various types of small portable barkers are being developed for peeling of fence posts, and it is possible that some of these may find application in the woods-peeling of aspen pulpwood intended for higher quality pulp products.

PROBLEMS IN NEED OF STUDY

The entire problem of stand quality and logging procedure in aspen needs further study. The small amount of information available indicates that for small stands and for low-quality aspen, mechanization may be uneconomical as compared to present practices. However, further study is needed to check the results of the one study made and to determine at what point in stand quality mechanization might be economical and what procedure would be most efficient.

Study of loading equipment that would reduce the amount of hand labor involved in loading green aspen is urgently needed. The work done in other regions with winches and various types of portable loaders should be reviewed and these methods should be tried with aspen.

The development work under way on portable barkers deserves added attention. The many machines that have been and are being developed should be investigated and tried in an attempt to find a cheap and efficient method of woods-barking aspen pulpwood intended for higher-quality pulp products. Although the process of applying chemicals to standing trees being investigated in Canada does not appear very promising under Lake States conditions, the results should be closely followed.

SUMMARY

Most logging of aspen, particularly of small tracts of pulpwood size, is by conventional methods. Preliminary study indicates that aspen pulpwood can be produced rather economically by a one-man crew using a bow saw and with dray skidding. In the study in question none of the mechanization procedures used resulted in reduced production costs for the type of stands logged.

Much of the power equipment now available and being applied to an increasing extent to other species does not appear to be well adapted to the logging of aspen pulpwood stands. In good-quality aspen stands, however, tree-length logging has been practiced successfully by several operators and a variety of equipment, including chain saws, mobile pulpwood machines, and mechanical loaders, has been tested.

The weight of green aspen pulpwood is generally accepted as about 5,000 pounds per cord, which is considerably heavier than spruce, jack pine, or balsam fir and emphasizes the need for mechanization of the loading process.

Green wood is generally preferred for the manufacture of wallboard, but for higher quality fiber products seasoned wood is preferred.

With the exception of some unpeeled pulpwood used in the manufacture of fiber board or for roofing felts, aspen pulpwood is peeled in mechanical barkers or by hand. Hand-peeling can be efficiently done only during the spring and early summer, from about May 15 to July 15,

when the bark slips easily. Some hand-peeled aspen pulpwood is still being produced by small operators and by farmers on their own woodland.

Most aspen pulpwood used by Lakes States mills is still being barked in the conventional drum barker but the "stream barker" is receiving considerable attention and has been used successfully on aspen.

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