

Operation of the Small Sawmill with Special Reference to
Operation in Oregon and Washington

by

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F O R W A R D

Although the total production of the small mills in the West is but a fraction that of the large mills, their importance is increasing and should not be underestimated.

The Author

INTRODUCTION

The object of this thesis is to present a picture of the types of small mills and milling equipment in use today, together with an idea of what we may expect in the future.

For purposes of description types of mills are classified as to kind of headrig, kind of power used, and according to portability. Included is a discussion on operation from logging to selling.

The reason the subject is deemed important is that both past history in the East and present trends in the West point toward an increase in the number of small mills in the West.

Personal investigations are limited to the Willamette Valley about Corvallis, Clatsop County, and restricted areas in Deschutes and Jefferson Counties. Literature consulted covers the country at large.

It is realized that topics are not covered in all their ramifications. Rather it is hoped that enough interest and curiosity will be aroused so that the readers will not be entirely satisfied, but will further pursue the subject of their own volition.

THE PLACE OF THE SMALL MILL

As foresters we are interested not only in the growth of successive crops of timber but also in the disposal of the timber we grow. Methods of lumbering have an important bearing upon choice of site for planting, diameter of crop when harvested, and silvicultural system employed. (8) The economics of operation on both public and private lands cannot help but determine forest policies. (1)

It is well, therefore, that the forester know something about the small sawmill, the types which are to be found, the types he may expect to find in the future, and bases for some of the problems which face the operators of these mills. He may be dealing with a small independent operator or he may have to negotiate with a large company which is operating a number of small mills. In any event it is to his advantage to be able to talk with the mill owner or manager in the millman's own language so he can maintain desirable co-operation and good will.

The material contained herein relates chiefly to milling in western Oregon and Washington. However, examples will be drawn from small mills the country over because small mills are merely the expression of a trend in the West but are established as practically the only kind of mill in operation in many of the eastern states. (3) The ensuing material is not intended to be an all-inclusive encyclopedia of information on milling. However, it does represent a sketch of the impressions gained from field trips to mills and from books

and bulletins covering the subject.

The original stands of virgin timber in the West have for the most part been converted into lumber by large milling operations such as the plants established by the Weyerhaeuser, Long-Bell, and Hammond lumber companies. An enormous amount of capital invested in a centrally located operation which could handle up to a million feet a day, as in one instance, has been the lumberman's answer to the problem of low cost production.

Most mills were established in places from which export is simple. Thus, in this region a majority of the larger mills are on rivers or bays, or in the case of inland mills, at the lower elevations where rail transportation is directly available.

However, with the depletion of the virgin stands, logging and milling of second growth demands that there be a revision in operating methods. Different problems are involved because second growth often occurs in isolated tracts. Furthermore, the logs are necessarily smaller. The large mill operators find it unprofitable to log and haul this smaller material long distances to be sawed.

Thus we have a new era for the small sawmill. Low capacity mills cutting from five to 30 or 40 thousand board feet per day are able to produce lumber for the same price per thousand large mills must pay for their logs at the mill. (11) Small mills have all but supplanted the large mills in the East (there were approximately 400 portable mills in

Pennsylvania in 1924) and are coming into the West to stay.(19) This in spite of the fact that 75 per cent of the small mills that start up are failures within three years, and a large number of the remaining 25 per cent provide mere subsistence to the owners. (4) In New York State today, only six mills saw more than 10 M per day, and of these six, four are band mills cutting 20 to 40 thousand feet of hardwood per day. (3)

Small mills, especially the portable type, are adapted for operation in isolated tracts of second growth timber.

Only a few million feet will justify the modest investment needed for a mill cutting five to ten M per day, and if it is portable, even smaller blocks can sometimes be economically utilized.

An enormous amount of waste which is to a large degree unavoidable when the time honored methods used for logging and milling virgin stands are applied to second growth stands is eliminated by the small mill. Because smaller logs can be handled profitably, less material is left in the tops. The introduction of small mills therefore, handled right, should meet with the hearty endorsement of agencies of conservation.

That the small mills can be expected to replace large mills is further illustrated by data regarding man-hour rates of production for certain industries collected by the Bureau of the Census in its biennial census of manufacturers for 1929. (16) Tabulations indicate that efficiency as measured

by man-hour productivity depends more upon the extent of mechanization and possibly wages paid than upon such factors as size of plant. In fact it decreases with size of plant, especially for those mills doing their own logging. The large mills are evidently working as near the highest profit combination as the market allows, instead of the least cost combination.

Another factor which is an advantage to the small mill is the fact that one may expect them to be able to utilize the 20 per cent (6) of the stand which is now left in the woods in Douglas fir logging as sound material but too small to be acceptable in the average mill (7).

Small mills escape many of the labor difficulties affecting the large mills. Union activities are at a minimum because of the small number of employees, many of whom are personal friends of the mill owner. Wages are often as low as \$2.50 a day.

Decentralization, then, can be taken for granted as a trend in western milling. More and more small mills are making their appearance. Closer utilization is being attained. This will be in keeping with the suggestion by William B. Greeley, (18) former forester for the United States, that a concentrated drive be made for elimination of waste in the manufacture and consumption of lumber. There is yet room for much improvement, however, in mills of all sizes for efficiency in getting maximum usable material from the log.

TYPES OF MILLS

Headrigs

In the past, in this region, the predominant type of small mill has been a semi-portable outfit using either a single or double circular saw. Lately portable outfits with a single circular inserted-tooth headsaw have made their appearance. Power has been supplied by steam boilers in the more permanent types and in the more portable mills the internal combustion engine has been the source of motive power. This can be accomplished by belt drives from caterpillar tractors.

The merits and disadvantages of the circular saw might well be considered at this point. Circular saws are in most cases quite wasteful. Quarter inch sawkerf is common. Also, considerable variation in thickness of boards occurs in the portable mills using circular saws. Circular saws, however, entail a smaller initial investment than band saws. Furthermore, a circular headsaw is solid on foundations not steady enough for band saws. A further advantage is that circular saws are easily maintained. The inserted-tooth feature makes their application desirable in small mills where a full time saw filer cannot be employed.

In the future, band saw rigs may become extensively used in the small mills of the Northwest. They are becoming increasingly popular in the South(17), where owners of the larger mills wished to decentralize their milling opera-

tions, but were not satisfied with the type of product the portable circular-saw outfits were offering because of inaccuracies in sawing. In answer to the demand of these mill owners for a portable mill which could saw lumber as true as the large mills could, the manufacturers devised a band saw headrig which is highly recommended.

Some of the advantages of the band saw are light weight per cutting foot, narrower kerf with consequently greater overrun, elimination of oversize sawing, and ability to saw large logs without a chipper.

Disadvantages include the fact that the band saw must be properly tensioned at all times on the wheel, a considerable amount of care is needed in operation, and it requires an expert to fit and maintain the rig.

The Clark Bros. Company, Olean, New York, has developed a portable band mill which is highly successful in the South. Instance of one of these mills in operation in North Carolina provides revealing data. The mill operates on a double shift and has a monthly production of 500M board feet, mostly in one-inch boards. A 50 H. P. motor provides ample power. In cutting white pine, two thousand feet of one-inch boards are cut per hour. The seventeen gauge band saw is eight inches wide. The total cost of the mill, including the building, installation, all motors, blower system, saws, belts, filing room, etc., is \$12,000.

This particular mill incorporates a number of economies not possible with a circular headsaw. Miscuts (thick and thin lumber) are eliminated, sawkerf is about $3/32$ inch, and the hourly production per man is nearly twice as much as with a

portable circular mill. Portable band mills as a rule require only half as much power. Furthermore, ten to twelve per cent more band-sawed lumber can be loaded on a truck than lumber sawed with a circular saw.

As a matter of interest, a band saw mill devised by the Forest Products Laboratory in Madison, Wisconsin, might be mentioned. To the best of my knowledge, no practical experimental mill has been set up as yet. However, a toy model has been constructed which seems to work satisfactorily. The mill has a moving horizontal band saw, the log remaining stationary. A carriage capable of moving heavy logs and yet remain in proper alignment is eliminated. The mechanism for moving the saw back and forth is relatively simple. Should this type of saw prove practical in actual operation, its advantages are evident. It has the disadvantage, however, of not being adapted for sawing out grades.

It appears that although the initial cost is somewhat higher, band saw mills may become more common in the Northwest. At present, with planks and railroad ties being the chief output of the small mills, it may be that installation of rigs adapted to cutting boards may not be economically feasible on many operations.

Another type of headrig we may expect to see in western mills is the gang saw. It is unlikely, however, that the Scandinavian gang mill will ever be used extensively as such alone. Rather it is to be expected it will be used in conjunction with larger mills for sawing of small stock. Logs

down to five inches in diameter can be profitably handled in this type of mill.(8) Possibly, as silviculture in this region is given more practical application, material from thinnings can be made to pay the cost of silviculture by utilization accomplished with a Scandinavian gang mill.

Scandinavian foresters have, through use of their gang mill, reduced the financial rotation to a point wherein commercial reforestation is a paying proposition. (10) In Sweden conversion of logs down to 3 1/2 inches in diameter showed a profit.

The amazing results in Europe led to an experiment at Olympia, Washington, in 1929. A gang saw mill was set up in April, and in June Roy F. Morse, General Manager of the Long-Bell Lumber Company at Longview, made a study on this test mill.

Morse reported as follows:

1. Raw material used was 6-20 inches in diameter (such logs as are commonly left after logging)
2. Cost of conversion was less than for either band or circular-saw mills.
3. Unskilled labor was used to advantage.
4. A greater percentage of overrun resulted because of:
 - a. Ability to handle small logs.
 - b. Thin gauge saws.
5. Logs were fed into the machine at a speed of 18 feet a minute.
6. The surface of sawed lumber was so free from irregularities that dressing was unnecessary except for special uses, as flooring.
7. Miscuts are unknown with proper installation.

The mill, in general, proved adaptable to the Pacific coast where stumpage values are low and wages are high. Its potential possibilities are yet scarcely appreciated enough.

About a dozen similar mills were set up in this country as a result of the experiment. The output of the experimental mill was sold for export six months in advance and for higher prices than band-sawed lumber of the same grade cut from virgin timber, because of accuracy in manufacture.

A rotation of 25-50 years would be feasible with a mill of this type in this region. However, in view of the fact that the mill is too expensive and hard to move about to attract small portable mill owners, destruction of our growing stock is not imminent. Rather it is to be expected the Scandinavian gang mill will be part of the standard equipment of large mills.

The National Committee on Wood Utilization is of the opinion that this mill is a most significant development in sawmill technique and will do much to further commercial forestry in this country.

Power

The small mill owner of the future will have at his option several kinds of power. Steam power, and internal combustion engines are in extensive use today, and in the future we should see an expansion in the use of electric power.

Steam is used in most the small mills today. Fuel is available from mill waste, and boilers can be purchased for fairly reasonable prices. Steam provides a constant supply of power. However, steam-powered mills are not very readily moved about. Furthermore, a fireman must be hired,

increasing the operating costs in wages.

Carriages are sometimes run by an automobile engine, and steam power used for cut-off saws, edgers, etc. In the small portable mill a diesel "cat" can be connected to belt-driven machinery. This type of mill is highly portable and has a further advantage in that the tractor can be used for logging and also used to run the mill, where continuous milling is not the object.

Many electric mills are in operation today, and with completion of the Bonneville Dam this type of mill may become very popular in this region. According to Hoffman of the USFS, of the 256 small sawmills in Washington in 1936 financed by large companies, most were electrically powered. These mills have a capacity of ten to twelve thousand board feet per day of operation.

Some of the advantages claimed for the electric mill are:

1. Elimination of shafting and belting
2. Decreased payroll
3. Increased production
4. Decreased building and foundation costs
5. Fewer shutdowns for repairs
6. Grouping and arrangement of machinery more efficient.
7. Maintenance charges less
8. Centralized power plant
9. Adaptability for future expansion
10. Decreased insurance and accidents

At any rate it is conceded that the margin of profit will be greater for the operation.

D.R. Sheaver, electrical engineer, (15) found in a certain mill that a 24 per cent saving of power is made with correct installation of electric machinery. Actual tests showed the following results:

Mechanical drive-- Friction load, line shaft and belting,
40 per cent

Electric drive--- Generator losses, 7%; motor losses, 7%;
line losses, 2%. Total 16 per cent.

It is reasonable to suppose, then, that electricity may be used extensively in small milling operations. Apparently the limiting factors are initial cost and the feasibility of power transmission to out-of-way districts.

Portability

Mills of the type described in this discussion may be stationary, semi-portable, or portable. For the purposes of this discussion a stationary mill is one which cannot be moved from place to place without complete dismantling and doubt-economic practicability. Semi-portable mills are mills in which units are fairly easy to transport. The source of power is not mobile, and is usually quite a problem in moving.

Truly portable mills are mills designed with the idea in mind that they are to be moved at frequent intervals. Portable mills can be bought from factories, ready made. The standard factory equipment includes tracks, carriage, and headsaw. Cut-off saws are additional.

Portable mills are available on the market which can be made to cut up to 20,000 board feet a day. A mill of this type, exclusive of power and saws, sells for about seven to eight hundred dollars, eastern price. Portable mills are proving successful in isolated stands of timber with diameters up to thirty inches. A really portable mill can be moved in half a day.

OPERATION

Logging

In studying the function played by the small sawmill by studying its operation, it is well to have at least a cursory knowledge of logging practices used in providing raw material. Certain elements of logging are much the same from one operation to another.

Yarding Equipment:

Donkeys are in use on about 35 percent (11) of the operations in Benton County. Types vary from the well known steam donkeys to gasoline donkeys. The latter are sometimes built up from used truck or caterpillar motors.

"Cat" logging has increased in the last decade and shows signs of being the most economical type of logging for many operators.(8) Combinations of horses and cats are in use by five operators in this county. The horses are used wherever the slope is too steep for the cats. Caterpillar logging is not as profitable as gas donkey logging during the wet winter months because the tractors are slowed down so much by the mud.

Horses alone are in use in many woods operations. Cost of hauling per thousand board feet varies widely so it is almost impossible to generalize. It appears that the small operator is doing well to consider all the possible methods of yarding available with reference to his particular operation.

Most small mills are located fairly close to the scene

of logging, in fact in a number of cases the logs are skidded directly to the log pond or rollway at the mill. When skidding directly to the mill is not feasible, logging trucks are commonly used.

Schroeder (11) points out that many small mill owners are wasting money in tram road construction on truck logging shows. He explains that plank tram roads cost from one to several thousand dollars per mile constructed, and that miles of these roads are being left to rot in the woods when a shift in operation is made. Rather, he says, than log new material and saw it into planking, the mill-owner should salvage the planking on abandoned roads wherever it is still in useable condition.

Silviculture:

Clear cutting is the practice in general application in the Douglas fir stands. Little or no thought is given by the average small operator to silvicultural factors. Second growth is being removed in much the same way virgin timber has been cut, only lighter equipment is used.

On the west slopes of the coast range a form of silviculture is being employed by at least one operator which should lend itself to the logging of stands in connection with the operation of small mills because it does not call for an actual cash outlay. The Douglas fir is removed, and an understory of hemlock is left. The hemlock is already established and is vigorous-growing. The stumpage value of hemlock should appreciate as time goes by, so there is small

incentive to let the land revert to the county for taxes. This is a kind of silviculture which can be practiced to advantage on small areas of timber.

In the Willamette Valley sustained yield operations would of course be desirable. However, most of the small mills are owned by independent operators who do not own enough stumpage to hope to log and mill on a sustained yield basis. The only objective which can be worked for, under present conditions at least, is to get operators to log with a minimum of waste, and with as much provision for regeneration as is possible with clear cutting methods of logging.

Milling

Many of the small mills I have been able to observe are not as efficient as they might be. Many of them have a limited amount of working capital. Also, in view of the prevailing low wage rates in most of the "woodpecker" mills, there is less incentive to purchase equipment which will reduce the number of men needed than there would be should the wage be as high as in the unionized larger mill.

Handling logs at the mill:

Mills located on creeks or lakes usually have ponds for log storage. Ponds are desirable chiefly because a fairly large number of logs can be stored at the mill (depending upon the size of the pond), and yet they can be moved about and brought into position for lifting into the mill with a minimum of labor. Furthermore, logs stored in ponds are cleaner. This is an important factor in localities where a layer of

mud and gravel accumulates on the surface of the logs in skidding, both from a standpoint of damage to the saws and of safety to the mill help.

Still water ponds are (21) generally more popular than ponds on streams. The chief advantage is freedom from storm hazards and flood conditions. Still water ponds were found preferable by the Fourth Sawmill Engineering Conference committee for the following reasons:

1. Ease with which logs can be handled at the log slip.
2. A lake or artificial pond is not as liable to suffer from extreme high water or severe storms which cause swift currents and consequent danger of loss, and difficulty of handling logs during these times of stress.
3. Less expensive construction needed.
4. Generally, on still water, advantage can be taken of wind in moving logs from one point to another.

Sinker logs are sometimes a problem in log ponds. Usually one end is afloat, so difficulty encountered is not particularly serious. Where the entire log sinks, it must be brought to the surface with tongs or pikes, and lashed to floaters.

Log ponds must be cleaned or dredged at periodic intervals because of debris which accumulates in the pond. Larger pieces can be thrown out by the piece. Buckets are necessary where smaller material clogs up the foot of log slips or the entire area of storage space.

Logs are usually skidded from the pond into the mill up an incline. The Winney Bros. Mill one mile west of Corvallis

however, has a well into which logs are floated and then lifted straight up into the mill with a cable lift.

Rollways are used where water for a pond is not available. Where there is no provision for storage, trucking has to be regular in order to keep the mill in constant operation.

If logs are to be stored at the mill they are piled so that they can be moved to the log deck with a minimum amount of labor. The rollway should have enough pitch so the logs will roll down to the carriage by gravity. In many small mills (18) too great an amount of hand labor is needed to get the logs on the carriage.

Logs are handled on the carriage by hand in most small mills. The ratchet setter on the carriage usually "dogs" the logs and often he also assists in turning the logs. Apparently there is room for much improvement in methods of handling the logs because it is definitely a time-wasting process in the average sawmill. Certain characteristics hold true for nearly all smaller mills.

Cutoff saws are usually of the swinging type, belt driven, and operated by hand. In some mills I have visited, the operator of the cutoff saw was not amply protected from accidents.

Edgers are lacking in many of the smaller mills, the edging being done with the headsaw. Dead rolls are also the rule, especially in the smaller of the small mills. In practically all cases sawdust from the headsaws and cutoff saw is taken care of by endless-chain conveyors. This material is sold whenever there is a market within profitable hauling dis-

tance. The same applies for hogged fuel and slab wood.

Lumber in the yards:

Because the small mill is often underfinanced and requires rapid turnover to meet overhead expenses, there is little place for storage of lumber in the yards. It is rarely that a small mill can store more than 100 thousand board feet at one time. Most of them cut to fill orders which are to be shipped immediately. What storing is done by the small mill owner would scarcely meet the approval of experts on seasoning yards.

A number of precautions are recommended to the small mill owner for proper storage of his lumber (18). Every pile should rest on three strong horizontal ground sills. It is a good idea to have the front sill somewhat higher than the other two. Also, the pile should be protected from the rain. Three or four stickers placed between the tiers of boards allow for circulation. Each sticker should be directly above the one below it. The stickers should be well seasoned.

Piles are usually six to ten feet wide, and should be at least three feet apart. It is further necessary that pieces of lumber be of approximately equal lengths because "overlaps" are almost certain to spoil.

For a small mill holding about 50 thousand feet in stock, a two-acre yard or piling space is necessary for proper storage. This will enable piling according to size and grade. The lumber yard should be on level ground.

Dry kilns:

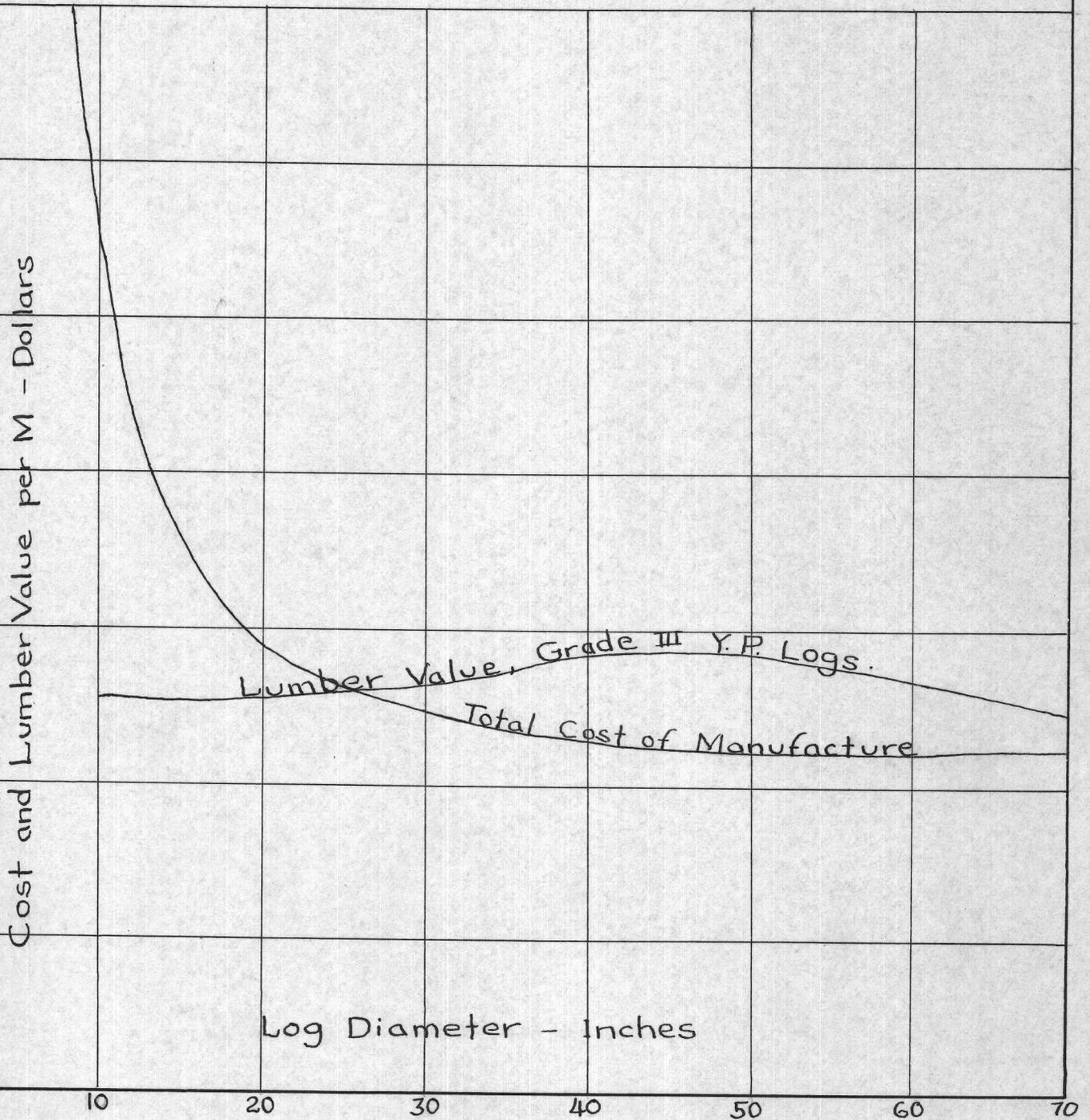
To date dry kilns have been completely out of the realm of the small milling operation. Small mill owners are of the opinion that kilns are for the larger mills. It has been shown however, that kilns can be made from lumber, whose cost would not be prohibitive. At any rate, a feasible idea would be for several small mills to co-operate and establish a "community" kiln.

Marginal Log

It is rarely indeed that a small mill owner determines what the marginal tree or log is for his operation. In fact, common practice is to saw anything that will make a plank or tie. Nothing is left in the woods which will make a salable product. Furthermore, a large number of operators have never heard the term "marginal log", and not a few think it a theoretical proposition which came out of the wanderings of a college professor's mind.

Nevertheless, most operators will concede that there is little if any profit in the small diameters. All the mills have a minimum diameter limit, but this limit is set by the decision as to whether there is merchantable material in the log rather than whether or not it can be handled at a profit. Eight inches is a common minimum diameter in this region. It is highly improbable that the sales returns from an eight inch log offsets the cost of handling. Many mills cut logs few of which ever exceed 24 inches in diameter. Operators have been known to state that they did not feel they were making any money on logs less than 15 or 16 inches in diameter, yet a check on the mills has shown these same

RELATION OF LOG DIAMETER TO PROFIT



operators to be handling logs down to eight inches.

The futility of handling logs which are too small for sound economic practice arises from a number of causes. For one thing, the logging costs are relatively much higher per thousand feet. According to W.W. Ashe, (2) the man capacity for felling and bucking eight inch logs is only one half that for twenty inch logs. Also, it takes three times as long to skid a given volume in eight inch logs as in twenty inch logs.

In milling it takes about twice as long to saw a thousand feet of lumber from eight inch logs as from twenty inch logs. Furthermore, the quality obtained is inferior.

One of the chief reasons the small operator cannot make a determination of the marginal log-- assuming that he is eager to do so-- is the fact that so few of them keep adequate records, or books. Some of the small mills in both the pine and fir regions do not have complete records of any kind. A large number merely retain their check stubs. It would therefore be quite difficult to make a scientific deduction in regard to the marginal log in view of the absence of sufficient accurate data. The process would be time-consuming because of this fact, and few mill owners are interested.

Recent studies made by the Forest Service would be of help to the operator. E.J. Lodewick and Axel Brandstrom, U.S.F.S., Region Six, have conducted studies on milling and logging which embody principles the small operator could use

to advantage. I am dubious as to whether the value of findings published in government bulletins would be appreciated by certain operators. In my inquiries regarding the marginal log I found it was necessary to explain to the operator just what a marginal log is. All of them were eager to know the marginal log for their particular operation, however.

Mill Run Studies

The logical way to determine the marginal log is through mill production studies. The necessity for "cutting to order" and the need for keeping inventories of slow-moving items as low as possible has brought home forcibly the need for better knowledge of the possibilities in each log. This knowledge can be obtained through careful mill scale studies.

According to E.J. Lodewick, U.S.F.S., mill production studies are neither too difficult nor too expensive for the average operator running a small mill. In fact they are relatively simple in mills where a capable and experienced crew is employed. Simplicity can be attained by restricting analysis to those logs whose conversion value is in doubt, or "border line" cases. Technique will vary with the size and type of operation. The amount of computation will vary directly with the number of samples. A majority of cases require several hundred samples for an acceptable working average.

Data needed in a mill scale study includes:

1. Type, quality, and size of log sawed.
2. Capacity and equipment of mill.
3. Sawing time per thousand feet lumber tally for

logs of different sizes.

4. Lumber recovery by sizes and grades for average logs of each size.

A method of procedure which can be followed on most small operations will follow below. It has been tested by the Forest Service with satisfactory results.

Points (1) and (2), above, are important in applying results derived from analysis in one mill to a similar operation. This can be done in cases where the mills are of approximately same capacity, have similar machinery, handle the same kind of timber, and have the same general floor plan.

Sawing time is recorded for each log in a mill scale study. The elapsed time is commonly taken as the interval between the moment the carriage is in position to receive one log and the moment it is in position to receive the following log. Whenever a delay occurs because of an emergency or from saw-changing, the loss in time is pro-rated over all the logs instead of being charged to the log on the carriage at the time. Sawing time is determined for each diameter of log.

The sawing time as first computed is on a basis of per thousand feet green lumber tally. Later it is changed to a shipping tally basis, allowance being made for losses between the green chain and the shipping dock. For a medium size mill in this region, these losses approximate one per cent.

To get the grade recovery it is necessary to make the

lumber from each log distinguishable from the lumber of other logs. This is done by marking the lumber from each log as it leaves the headrig and following it through the mill. Green-chain tallies for each grade are also adjusted to allow for degrade and footage losses resulting from seasoning and handling, and converted to shipping tally. Thus the grade recovery from each log diameter is expressed as the footage of each grade shipped rather than as the footage on green chain tally. This is necessary because selling prices are expressed in terms of lumber ready to ship.

Manufacturing costs are figured for each size of log included in the study. Costs used are average costs for a given period in the economic cycle. It is a good idea to divide costs into direct milling costs and other manufacturing costs, including those chargeable to the yard administration and planing mill, if one is in use. The direct milling costs are applied against logs of various diameters in direct proportion to the time required to saw logs of each diameter, while other costs are distributed according to the lumber recovered because the latter costs do not vary with the size of the log.

To assign milling costs to log diameters after the sawing time per thousand has been computed, one must know the per-second cost of operating the mill. Average sawing time for all logs is determined by dividing the time the mill operated by the footage (shipping basis) produced. Average milling cost per second is then obtained by dividing milling

cost per thousand by average sawing time per thousand. To get the milling cost per thousand for any diameter, then, it is only necessary to multiply this cost by the sawing time per thousand. Total manufacturing cost is obtained by adding to this figure the other manufacturing costs, which are taken as a flat charge.

Value of the products obtained per log of a given diameter are the product of the percentage of each grade and the current selling price. Conversion, or net return, on a log of any diameter is obtained by subtracting total manufacturing cost per thousand from recovery value per thousand. This figure is the maximum amount which can be paid for logs at the mill.

In application of data from one mill to another mill, it is imperative that the two mills are basically similar. A check should be made on a few randomly selected logs, and if any appreciable variation exists, some fundamental factor is different so the data cannot be applied.

There are occasions in which it is desirable to saw a log with a negative conversion value, such as the filling out of orders. Such cases are up to the judgment of the mill manager.

Selling

Selling, as pointed out by Mr. O. Miller, (9) ex-president of the Pacific Logging Congress, is the biggest problem confronting the operator today. Mechanical means of production have been and are being perfected to a degree which places that phase of milling far ahead of selling. Many mills

which become bankrupt do so not because their margin of profit is too low but because they are able to operate only a part of the time for lack of orders.

The small mill owner is handicapped in this regard . He does not have a sales force operating in the field as does the large operator. He is often a practical mill man who worked through the ranks and is not able to find markets as well as he is able to run his mill. If he works in his own mill he does not have time to contact buyers nor does he have the necessary "contacts" which in many cases are quite helpful.

Small operators therefore usually sell through brokers. Sometimes this method of marketing is supplemented by local sales. Brokerage charges vary from a straight \$.50 per thousand board feet to eight per cent of the gross receipts. Successful mills sell their output for cash or negotiable paper. "Cash within two weeks" is a slogan with a number of small operators.

The U.S.F.S. Experiment Station (11) discloses an interesting charge in regard to brokerage fees. The average small operator does not know enough about grading to grade his own lumber. The broker handling a carload pays him the prevailing price for the lowest grades in the lot for the entire load. The lumber is taken to some central shipping point and graded. Thus the broker is enabled to sell some of the load at a higher price, thus adding a considerable amount of "gravy" to his regular commission.

Fire Protection

Protection from fire is just as necessary at the mill as it is in the woods. Insurance charges for fire on the ordinary small mill are quite high. A premium equal to 20 per cent of the value of the mill is not unusual. For this reason many operators do not carry insurance (18) policies protecting their mills but provide what fire protection they can of their own. Accessible water hoses and chemical fire extinguishers can be used for this purpose.

Social Phases

Living conditions of the mill help are not often attractive probably because of the temporary nature of most small operations. In some cases housing accommodations are above reproach. At many mills in the Willamette Valley and on the coast, especially during the winter months when the mud becomes a problem, living conditions are actually squalid. (11).

In the future, however, pending wage increases and the improvement of roads, it may be that mill help will be able to live at a nearby town and go to work each day by automobile. A more stabilized social structure will be the result, with fewer ghost towns. (13)

Economics of Operation

It has been pointed out that a large number of small mills are financially unsuccessful - that 75 per cent of those that start up are bankrupt within three years after starting. One of the chief reasons is that small mills run by independent operators are under-financed. They are run on a "shoe string" basis and do not have enough working cap-

ital to tide them over the rough spots. They are not able to saw for storage, but must wait for orders and lose out with their limited capacities when markets are good.

Another reason is that the operator of the small mill is not usually equipped with an adequate background to enable him to be a successful mill owner -- his tools of management are not well developed, and often lacking. He may be a first-class sawyer or mechanic, but the mill owner to be successful in running his operation must be a truly versatile man. Generally he is not an efficient business man.

A further reason for failure is expansion of the mill when it is not warranted, or acting upon a short term normal price as a basis for added investment for increased capacity.

A particular instance comes to mind wherein a shingle mill owner bemoaned the fact that he was unable to fill all the orders offered him. He and his partner contemplated enlarging the mill, decided to postpone doing so, and three months later were glad they didn't. A factor contributing to failure of many small mills, then, is failure by the operator to realize his limitations.

The problems confronting the operator, no matter how small his mill, are both diverse and complex. In answering the question, "Just what does it cost to manufacture a thousand feet of lumber?", J.S. Webster, (14) Trade Promotion Engineer for the American Saw Mill Machinery Company, says:

"This is a very ambiguous question, something like as-

king: How fast may I drive an automobile? Most anybody will readily understand that the speed of the machine will be determined by the make or quality of the automobile, its mechanical condition, and the road over which it is driven."

What the prospective mill owner must know is just what he will need to take a given piece of timber, log and manufacture it into proper grade and dimension for the present market conditions at a minimum cost per thousand.

In buying his timber, the purchaser may well ask himself: Is it the kind and quality that is readily saleable? Is it a profitable logging show? What is the percentage of defect? Is the fire risk unusually great? How far is it to a shipping point? Are there any local differential charges? All these questions must be answered satisfactorily before the buyer can determine what the stumpage is worth to him.

Before the small operator is in a position to select the type of mill he needs he should have the kind, size, and quality of his timber well in mind, his mill site properly located for convenience in logging, and space for disposing of refuse from the mill. He must also take into consideration the length of timber he intends to saw, as this will have a bearing on the length of carriage and spacing between between rolls.

Power required will depend upon the volume of production which is desired. Plenty of reserve power is desirable both from the standpoint of efficiency in production and life of the machinery.

Good machinery is essential for successful mill operation. A number of failures may be contributed at least in part to the fact that equipment worn out a generation ago was used. (12)

Suggestions, Comments, etc.

Beyond a doubt much can be accomplished by co-operation among the small operators. Community dry kilns, co-operative sales forces, and co-operation in road construction should prove to be projects well worth the undertaking.

A further suggestion which might tend to eliminate failures is that the operator subscribe to at least one good trade journal covering his field. Market analysis data, specific ideas, exchanges of experiences, and latest developments in machinery are included in the best trade journals.

The value of mill run studies is self-evident. Perhaps student projects in this line can be encouraged.

Conclusion

It will be noted that taxes have been omitted from the above discussion. This is because of the fact that the whole tax problem is so complex and involved that adequate treatment has no place in a treatise of this nature. It was therefore deemed wise to omit mention of it entirely.

In summary, there is evidence of, and good reason for, a further increase in the number of smaller sawmills in the West. Operators of these mills have problems peculiar to their trade, so the technical forester might well concern himself with a knowledge of how these mills operate to the

extent that he can speak eye to eye with the operators.

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